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J Erxleben del. A Forre, Photog. Day & Son, Lith.rs to The Queen

SHEEN LODGE, RICHMOND PARK, the residance by ROYAL FAVOR of PROFESSOR OWEN.

The Triumphs of Owen.

By the Muse of the Museum

(Slightly askew from Gray) Gray

"Owen's praise demands my song,
Owen wise and Owen strong,
But in spite of Owen's stout,
All the beasts must toddle out.

Out with wearles, jerseys, skunks,
Elephants, come pack your trunks
You no longer dwell with us,
Yawning hippopotamus.

Dusty, straddling, split giraffe,
You have strayed too long by half
Go and take some nice fresh air
With that grim-eyed Polar bear.
"~~Fish, fish, fish,~~ "yous
"Fish, fish, fish," your Duty calls,
Somewhere else than in these walls
Flounders, you must go, that's flat
With the salmon and the sprat.

Cloud of birds, ascend and fly.
Migrate to some kinder sky

Perky, shiny, glittering things
Leave the wing that holds your wing,

Fossil ~~Hare~~ wench too you must pack
Take your ~~Crab, Fox~~ coffin on your back
Or, if you'd prefer a ride
Mount the ~~Hamster (inside) by your side~~ Mastodon (inside)

Eggs, be blowed, if you're not break,
You your eggsit now must make;
Yes, your yolk must turn to legs
Yes, assure as eggs is eggs.

All those myriad butterflies,
Pins and all must please to rise
We can use in other ways,
Miles of camphor scented trays

Diamonds black and diamonds bright
Henceforth charm suburban sight
Follow beasts and birds and bones
All you tons of labelled stones

226302

The Period

PROFESSOR OWEN——On his Favourite Hobby. Jan 29, 1870

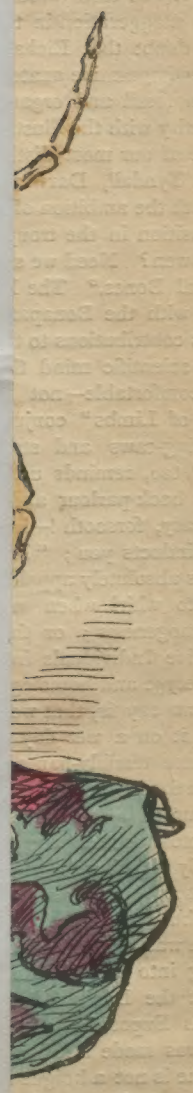
From that yellowish liquor take
Every coil, you spotted snake,
"Bonny beetles in a row"

Stir your stumps for you must go
Mother Nature beat retreat
Out Mam, from Great Russel Stow

Here in future folks shall scan
Nothing but the works of Man

Yet look glad for Owen stands
Moulding Gladstone to his liquor
Soon you'll have a Palace new
Worthy Owen, us, and you.

(Punch.)



PROFESSOR OWEN——On his Favourite Hobby.

The Period Jan 29, 1870

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PROFESSOR OWEN——On his Favourite Hobby. Jan 29. 1870

The Period

chard Owen, F.R.S., was born at Lancaster in 1804. graduated at the University of Edinburgh; was ght up to the medical profession, and became a ber of the College of Surgeons in 1826. To his equent appointment as Hunterian Professor and tor of the Museum of the College may be perhaps be the development of his great intellectual powers, their concentration in the departments of natural ty and comparative anatomy. *Ex quovis ligno fit curius;* and from the contemplation of the skeleton e Irish giant in Lincoln's-Inn Fields young Owen may been led to vasty theories concerning mastodons and nodons, gigantic sloths and monstrous ichthyosauri; moths much bigger than the biggest whales, and odean birds to which the ostrich would be but as a bler-pigeon. "Genius," said Johnson, "is only a ral capacity directed into a particular channel." general capacity of Richard Owen was directed into particular channel of compiling an illustrated descrip- catalogue of the contents of a surgical museum; yet ose comparatively humble labours may be remotely ng the Professor's famous works on "Odontology," "Palæontology," and on "Organic Fossil Remains." as been said that if the mere imprint of the foot of animal in a lump of clay were shown to Professor en, he would at once be able to prove to demon- tion what kind of creature owned the foot in ques- ; how many cervical, dorsal, lumbar, and caudal ebræ it possessed; whether it was wild or domestic, ther it was carnivorous or herbivorous. There may some exaggeration in this estimate; but there cannot any doubt that Richard Owen is the most distin- shed comparative anatomist in Europe, and that, as a ter on fossil and organic remains, he will be ranked posterity with the illustrious Cuvier.

f five of our most distinguished *savants*, say, Owen, xley, Tyndall, Darwin, and Murchison, were to be ed with the ambition of rivalling the Christy Minstrels, at position in the troupe would be assigned to Pro- sor Owen? Need we say that it would be that of the riginal Bones." The Professor might almost claim ed with the Bonaparte family, so numerous have n his contributions to the literature of osteology. To non-scientific mind the titles of some of his works uncomfortable—not to say alarming. "On the ture of Limbs" conjures up unpleasant images of putating-saws and strapped-up stumps; "Odonto- phy," too, reminds us, we scarcely know why, of a tist's back parlour and that hideous morocco easy- ir—easy, forsooth!—into which the deceitful tooth- wer inducts you; "Memoir on a Gigantic Extinct th" is absolutely appalling in its title; and our brain ins to whirl when we picture the Professor on arthenogenesis; or the Successive Production of creative Individuals from a single Ovum." As for archetype and homologies of the vertebrate skeleton, we can say is, that we should be very averse from ding it on a wet day in the month of November. er these terribly-named works of the Professor, his ks on the Dodo, on the Aye-Aye, and the Gorilla, may accounted quite light literature; and there is some- g almost poetical about the title of the "Memoir on Pearly Nautilus."

Professor Owen has not only been an indefatigable dent, but has likewise led a very busy and useful public

He was a member of the original Commission for airing into the Health of Towns; was President of es at the London Exhibition of 1851 and 1862, and Paris Exposition of 1855. On the last-named occa- he was made a knight of the Legion of Honour. Of rse, he is not a knight of any order which the British wn has to bestow; but he once had the high honour elivering lectures before the Royal family at Bucking- m Palace and at Windsor Castle, and a residence in hmond Park has been assigned to him. He also ds a public appointment as Superintendent of the partments of Zoology, Geology, and Mineralogy in the tish Museum. And did he not lately accompany the nce and Princess of Wales in their visit to the East? ely these honours should satisfy the most ambitious men. But Richard Owen, we believe, is the very erse of ambitious. He has lived only to learn and to

6 ... POPE PIUS IX. & CARDINAL ANTONELLI.
7 ... FECHTER—Bidding adieu to Britannia.
8 ... DR. CUMMING—Taking advantage of his Prophecies.
9 ... ADMIRAL ROUS—Repelling the Turf Harpies.
10 ... ALFRED TENNYSON—Laureate of King Arthur.
11 ... OFFENBACH—The Inexhaustible Melodist.
12 ... CHARLES MATHEWS—The Young Stager.
13 ... U. S. GRANT—President of the Great Republic.

*** *Any Number sent post-free for Three Stamps, or Two Numbers for Five Stamps.*

THE PERIOD.

SATURDAY, JANUARY 29, 1870.

"CIRCULATION."

THE observant student of the English press must have often noticed the insane desire which most of our journals exhibit to inflict upon the public the details and the characteristics of their circulation. Thus we have one paper advertising "the largest circulation in the world"—that is to say, a circulation considerably less than some of the journals of Paris and New York. Even if this vain-glorious print *had* the largest circulation in the world, it is no criterion of merit; and indeed we find that the staple contents of its sheet are advertisements, and not news or original matter, which we naturally desire to obtain when we buy a newspaper. Another daily brags of the "largest London circulation," a statement which must also be received *cum grano salis*, and we expect shortly to have an evangelical weekly boasting of "the largest circulation at muffin-worries," or the *Globe* claiming the same privilege among Tory washerwomen. "Good wine needs no bush," and we always expect to find evidences of literary weakness in a paper that is perpetually reminding the public how many victims purchase it daily.

Circulation, however, is to a certain extent a desideratum, and the antics performed by some of our contemporaries to gain popular support are indeed curious. The *Pall Mall Gazette*, for instance, has during its career been perfectly Protean, so wonderful and so rapid have been its changes. It commenced as a twopenny evening paper, written "for gentlemen"; then it touted for the pennies of the *hoi polloi*, coming out, still in the evening, at that reduced price, and being careful to inform us that it had never been conducted with any ignoble desire of filthy lucre. Not very long afterwards the world was astonished by an announcement that it was to come out in the morning, with a change of price to the twopence of its early days. This announcement was worded in a way which showed not only that the conductors did not know what it was they desired to say, but were not able to explain themselves if they did know. There is said to be wisdom in a multitude of counsellors, but we doubt the wisdom of many changes in the case of a newspaper. Whatever its politics may be, it should always be conservative as regards its form and price. Readers will not be tormented by editorial indecision, as our contemporary will, we are afraid, find out.

We are apt to boast of our free press; but, after all, we doubt whether our newspapers have much improved of late years. They have studied overmuch to attract the *profanum vulgus*, and have become essentially vulgarized and debased thereby. Style is neglected for sensationalism, and facts are disregarded in the heat of party warfare. Added to this, the public is fairly pestered with papers. We have too many rival claimants for the honour of teaching us everything under the sun, and we predict that in the course of the present year of grace we shall see the ranks much thinned, and many journalistic corpses carried to the rear. We are aware that we are open to a pitifully obvious retort in saying this, but the knowledge of that shall not prevent our prophesying what we believe the days to come will amply verify. *De mortuis nil nisi bonum;* we will deal gently with our extinct contemporaries when they have gone to the grave of the butter-man, and the world knows them no more.

himself at will, and, marvellous to be related, ev dulging in the rough horseplay for which he is celeb refrains from inflicting wanton damage upon any and shrubs with which the Park is decorated. spectacle presented is of an exceedingly animated various eligible young men and charming damse Hackney promenade gracefully to the music of a band, and the children of Israel make manifest tional love of purple and fine linen still flourishes

Now to all these good folks the Victoria Par mable boon, and it is with great consternation heard a rumour which has recently gone abroad that Mr. Ayrton, being of the opinion that too annually spent upon their place of recreation in &c., is about to cut off the supplies, and reduce barren and desolate condition of Leicester Squar now that retrenchment has become the first princi ment, it follows that Mr. Ayrton should endeavo many good marks as the rest of his colleagues, a sacrifice of the *utile* in the shape of our dockyard must not wonder to see that of the *dulce*, as c flowers of Victoria Park. But how strange i flowers, which are an expense in London, shoul source of revenue in Paris. The Serres de la besides completely paying expenses, bring in no augmentation to this latter city's revenue from the plants. All the magnificent semi-tropical veg adorns the various squares and places of the during the summer months is carefully shelter winter in immense greenhouses situate near the A and such is the gigantic scale and economical prin these establishments are conducted, that the me surplus stock to nurserymen, florists, &c., at wh not only suffices to cover all expenses, but leaves a for profit; whilst by thus confining all transactions sale market, no opposition is made to private trad British Government have taken the telegraphs, surely have no objection to try their hands at a litt if they see a chance of making a profit.

TABBY OR NOT TABBY.

ANOTHER glorious gain effected in the publ ture! Mr. Childers has given orders for a r the supply of food to the dockyard cats. *Ma* Cadaverous grimalkins stalking about the henceforth proclaim the wisdom and huma economical government. But why, O sage Chi thyself to the stinting of the animals? Why not them altogether, sell the fur, and hand Mr. balance? So would a grateful country bless the Toms be minus their misery. "Childers and tion of the Cat in the Navy!" would be the tinction is better than slow starvation, as even decide if she could vote on the question.

"I'd rather be a kitten and cry mew!" cries Ho Hotspur, you would not willingly be a docky under a Liberal government: to linger on half- hunger for the rats poisoned by Mr. Childers rat-catchers; to cry with Goethe for "Lights, m to miserably mew and piteously purr, puss, all pose. Such a life is *not* to be preferred. But console herself: Government began by starvin and was only compelled by inexorable logic economy to the quadrupeds. It began, at with the meaner creatures.

THE CYNIC AT AN EVENING PART

No. 10.

GASTER!—How do? Away the glutton goes,
To strive for edibles upon the landing.
He of a cow, as everybody knows,
Has got the stomachs *and* the understanding.

No. 11.

Pauline, that would-be synonyme of grace,
Possesses, did you say, an angel face?
One seraph trait alone in her I see:
Angels are painted fair, and so is she.

No. 12.

That titled hag, who lives to hate and lie,
Is spitting forth the spite that fills her craw full
"People tell lies of me!" you hear her cry;
And well they do: the truth would be too awf

No. 13.

Behold De Hosier, styled of friends too warm
"The glass of fashion and the mould of form."
The mould's a composite, with padding packed;
As for the glass, it certainly is cracked.

Yours always truly,

Rich'd. Owen.

A CORRESPONDENT CORRECTED.

BY RICHARD OWEN, M.D., LL.D.

When we are in possession of facts that go to correct misapprehensions, it seems right to present them; but especially if that correction tends to remove prejudices regarding prominent individuals or classes of men, it appears an imperative duty not to withhold them.

These remarks apply to an article communicated to THE INTERIOR by Dr. Van Doren, and published in the issue of May 2, 1872. In that article, when commenting on "Huxley's Discovery," which is the title of the communication, Dr. Van Doren argues against and ridicules the Darwinian hypothesis, and in one paragraph says: "The thanks of all persons who have ever had an heartache or a troubled conscience, are due to Messrs. Darwin, Huxley, Owen, Grove, Schultze, and others of that class." This would be generally understood as conveying, and was, I presume, designed to convey the impression that all of these scientific men adopted the so-called development views, and as the article goes on to show that such opinions "get rid of an immortality," the conclusion is natural that all of them are skeptical.

The Owen here designated is evidently the great Comparative Anatomist, Professor Richard Owen, formerly at the head of the "College of Surgeons," London, now head of the British Museum. As I had the pleasure, two years ago last summer, of spending half a day with him, at his delightful country residence, and of eliciting his views especially on religious subjects, I believe I am able to give accurate testimony.

However, I will not trust to my memory alone, nor to the copious memoranda made immediately afterwards, but will offer some extracts from an address delivered by Professor Owen before the Young Men's Christian Association in London.

I have used Owen's works for many years, and now employ them in connection with my classes in the Indiana State University, and have invariably found him opposed to the Darwinian theory. But when I met him personally, being myself an elder in the Presbyterian church, and having delivered a series of lectures at several places, designed to show that there is no conflict between Genesis and geology, I felt desirous to probe Professor Owen's views more deeply than I could do by reading his scientific works, and he very kindly referred me to his printed copy of the address above alluded to, and permitted me to make extracts, as the edition of the pamphlet was exhausted. Some of these extracts, bearing especially on the point in question are herewith subjoined:

"Cease, then, to take alarm at each new ray of light that dawns upon a field of the Divine power."

"The light, bright as it is contrasted with the darkness it has dispersed, penetrates but a short way into the illimitable theater of the operations of Infinite powpower."

"Allay then your fears; trust in the father of all Truth, who has decreed that it shall never perish, and has given to man a power to acquire the most precious of his possessions with an intellectual nature that will ultimately rest upon due demonstrable evidence."

"Search the Scriptures with a mind as free from preconception as may be possible to a finite and imperfect nature, free especially from every system which may have been built up by the wit or wisdom of man through selection or adjustment of Divine utterances."

"As much as may be, become again as little children, in seeking guidance from Holy Writ. Above all, square your actions by Christian ethics; for he that doeth of the will shall know the doctrine, whether it be of God."

Judging not so much from these extracts as from my conversation with him, I feel fully justified in saying that Prof. Owen, of the British Museum, is a Christian man, admiring and practicing, in every day life, the precepts of the Bible. Whether his views are in every respect such as would generally be called orthodox I am unable to say. He is certainly not sectarian, and evidently objects to such partial reading, selection and adjustment, as shall establish doctrines upon single passages, instead of collecting and comparing all apparently conflicting passages and adopting the great general truths so amply sufficient for the guidance of the Christian's conduct, and upon which all Christians can unite.

For the sake of science, for the sake of Prof. Owen, of London, but especially for the sake of those who might stumble and find excuse for doubt, if they adopted the view that the great majority of scientific men are skeptics, I have deemed it my duty so far to trespass on the beautiful privacy revealed to me by the hospitable courtesy of one of England's most scientific and best of men, as to record the above facts.

1872.

Societas Palæontographica.

— Jura —

Palæstinum Testaceum

— Pisces. —

Soleæ inassæ Batavorem more
Salmo secundum Buckland
Asini marini secundum Owen
Alburni cum pane cocti in furno
Clupeæ quædam mites - alteræ diabolorum more confectæ.

— Paropsides. —

Anates albæ lento igne coctæ.
Columbæ minutæ cum fusco jure elixæ
Agni seminum cucumeris condimento
Bovis linguæ pulvere ardenti Indico more conditae.

— Carnes. —

Sella ovina Agnina pars quarta assa
Pullæ modo Bechemel assæ.
Petaso Westphaliæ cum ovo acipenseris
Cervi lingua infumata septentrionali modo.

— Ferina. —

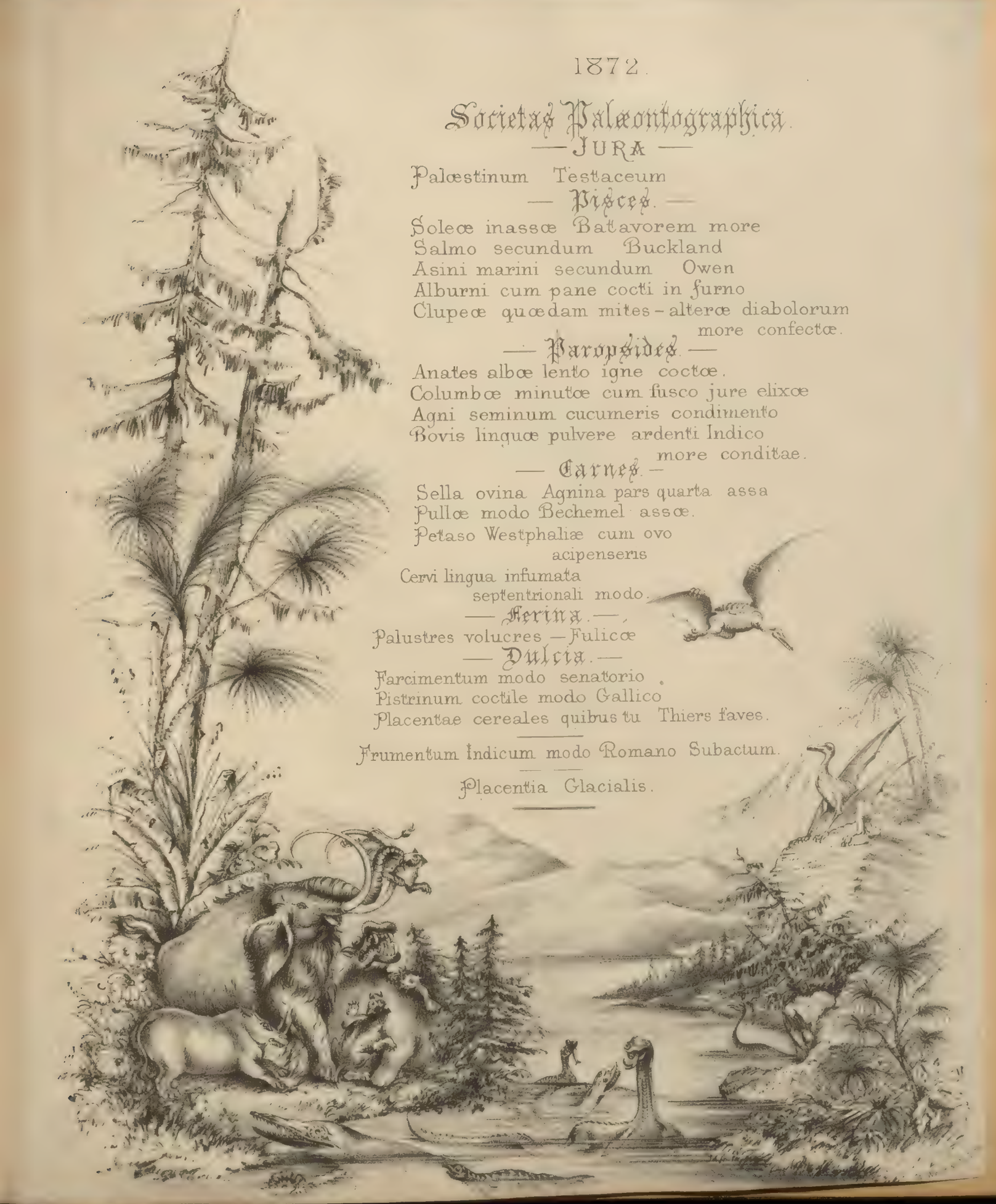
Palustres volucres — Fulicæ

— Dulcia. —

Farcimentum modo senatorio.
Pistrinum coctile modo Gallico
Placentae cereales quibus tu Thiers faves.

Frumentum Indicum modo Romano Subactum.

Placentia Glacialis.



PROFESSOR RICHARD OWEN, C.B., LL.D., F.R.S.

Sincerely yours
Richd. Owen.

NO man of science is more widely known and honoured than Richard Owen. At a very early period of his remarkable career he made science generally interesting, long before it became a popular or fashionable pursuit. For upwards of half a century he has been actively engaged in a vast number and variety of researches, many of them directly bearing upon the welfare of humanity as well as the extension of that abstract knowledge with which his name is more usually associated; for his work has frequently been of a highly practical nature and of material public benefit. To this category belong his Reports as one of the Commissioners of the Health of Towns, and that on the meat supply of the metropolis, which resulted in the removal of the cattle market from Smithfield to Copenhagen Fields. He also served as one of the Commissioners for the Great Exhibition of 1851, and as Vice-President of the jury for food products in that of Paris four years later. But the most important outcome of his public labours is that which sprang from his continued representations to the Treasury concerning the unsatisfactory accommodation provided for the national biological collections in the British Museum, which were undoubtedly instrumental in procuring the erection of the new natural history museum at South Kensington—at once of permanent advantage to his countrymen, the cause of biological science, and an enduring monument of his official influence and activity.

His public life falls naturally into two epochs, that of his connection with the Royal College of Surgeons in Lincoln's Inn Fields, and his appointment a quarter of a century later to his present post of superintendent of the Natural History Department of the British Museum.

Richard Owen, the youngest son of Richard Owen, Esq., of Fulmer Place, Bucks, was born at Lancaster on July 20, 1804. In early youth he served as midshipman on H.M.S. Tribune, but all prospects of naval advancement were speedily clouded by the peace which ensued at the close of the American war of 1814. The youthful middy returned to school on shore, and subse-

quently studied medicine under Mr. Baxendale, a surgeon of his native town. In 1824 he matriculated at the University of Edinburgh, and two years later received the diploma of the Royal College of Surgeons in London, where, as a student at St. Bartholomew's Hospital, he acted as dissector under the famous Dr. Abernethy, who quickly recognised his remarkable talent. A visit to Paris was the next turning-point in his life. There he worked in the laboratory of his master and friend the great Cuvier, then at the zenith of his fame as a comparative anatomist. On returning to England Mr. Owen procured an appointment as assistant surgeon in the navy, but was induced to resign it through the energetic representations of his staunch old friend Dr. Abernethy, whose influence secured him a more congenial post as assistant to Mr. William Clift, F.R.S., then engaged in cataloguing and arranging the magnificent collections of John Hunter, purchased by Government, and transferred to the museum of the Royal College of Surgeons, of which Mr. Clift was conservator.

For some time the young surgeon also practised in Serle Street, Lincoln's Inn Fields, and although his keen insight and great abilities would probably have ensured him wealth and distinction as a physician, he gradually abandoned the medical profession for a life's devotion to research, content with smaller emoluments and greater leisure to work hard for the advancement of science and the increase of knowledge. That his life has been one of unintermittent labour his published works fully testify, for he has toiled with almost superhuman energy and persistent regularity, investigating the structure of all classes of the animal kingdom. His contributions to literary and scientific periodicals alone number nearly four hundred. Many of these are important memoirs embodying new facts and valuable discoveries. They are to be found in the Transactions and Proceedings of the Zoological and Linnæan Societies, the "Philosophical Transactions," the quarterly journals of the Geological and Microscopical Societies, "Annals and Magazine of Natural History," the reports of the British Association, "Geological Magazine," the volumes of the Palæontographical Society, "Encyclopædia of Anatomy and Physiology," the "Medical Gazette," "Encyclopædia Britannica," the "Athenæum," "Fraser," etc., etc. To these must be added the many important technical works published by Longman, Black, Van Voorst, and others, to which we shall have occasion to refer in detail.

One of the most interesting and important of his earlier memoirs was that in which he made known the physiological structure of the pearly nautilus. This was published by the council of he Royal College of Surgeons when Mr. Owen was only twenty-seven years of age, and illustrated with his own drawings of the animal his fellow-student, Dr. George Bennett, of Sydney, was so fortunate as to procure during a voyage in the Polynesian seas. For this was the first specimen of the animal available for description since the days of the Dutch naturalist, Rumphius, in 1602, whose imperfect account of its anatomy was preceded only by that of the great father of natural history, Aristotle, who was evidently acquainted with the living species of the Persian Gulf. Cuvier had always longed to know the structure of the animal inhabiting the nautilus shell, and it was with keen regret that his young English disciple learnt of his death a few days before the "Memoir on the Pearly Nautilus" was issued from the press in 1832.

During the next decade Mr. Owen gave considerable impetus to the development of the science records of the Zoological Society, to which he acted as unpaid prosector for many years; thus laying the basis of his intimate knowledge of the physiological anatomy of the many rare and bulky animals from all parts of the world that died in captivity in the society's gardens. He also contributed frequently on pathological subjects to the Medical and Chirurgical Societies of London.

In 1834 he gained his title of professor on his election to the first chair of Comparative Anatomy at St. Bartholomew's Hospital. Two years later he was elected a Fellow of the Royal Society, and was appointed to the Hunterian Professorship at the Royal College of Surgeons. His lectures in this capacity on the anatomy of the specimens in the Hunterian collections were the foundation of his published works on "The Comparative Anatomy of the Invertebrate Animals," and "The Anatomy of the Vertebrates," enlarged and profusely illustrated and published in three quarto volumes by Longman. Each succeeding year witnessed his deeper immersion in the study of comparative anatomy, and gave proof of the wide range of his genius and the fertility of his brain. His catalogue of the Hunterian collections, of itself a life-work for less energetic toilers, was published by the council of the college: the five quarto volumes of the physiological specimens from 1835-1840, the two volumes of osteological collections in 1853, and three on the fossil vertebrata and cephalopoda in 1855. The Microscopical Society of London, of which he was first president, owes its origin to his influence and ardent labours in the cause of microscopical research. His work on the microscopic structure of teeth (odontography) temporarily affected his eyesight, and he was compelled to desist a brief while from similar investigations. The remarkable memoir "On the Archetype and Homologies of the Vertebrate Skeleton," in which he effected a much needed reform and unification in osteological nomenclature, appeared in 1849, and was followed by "The Nature of Limbs," a popular exposition of the same subject, and the memoir on the curious phenomena of asexual generation, or "Parthenogenesis."

Professor Owen was one of the earliest contributors to the annual volumes of the Palæontographical Society of Great Britain, formed in 1847, to describe and illustrate the structure of the fossil animals that lived at various geological epochs within the area of the British Isles. In the course of the valuable series of monographs and supplements which he still continues to issue, he has restored the extinct flying reptiles of the

air, the swimming lizards of the sea, the turtles and tortoises of the tertiary and middle geological ages, the early and imperfect-toothed mammals of the Stonesfield and Purbeck areas, and the bulky land reptiles, the iguanodon of the Sussex Wealden and his ancestors and allies. Later on came memoirs on the sea-serpents of the tertiary epoch of Bracklesham, with the gavial, the crocodile, and the alligator, that then disported themselves in our rivers, on the ostrich-like bird (*Dasornis Londinensis*) which haunted the thicket-covered shore of that ocean-floor now elevated into the Island of Sheppey, whence the serrated jaws of that other famous bird, the *Odontopteryx*, the subject of a later memoir, were derived. Some of the results of these researches on the ancient British faunas are epitomised in his "History of British Fossil Mammals and Birds," published in 1846, and the "History of British Fossil Reptiles."

While busied in illustrating life in the past epochs of our island home, Professor Owen was far from neglectful of the geological life records of the British colonies. His persuasive temperament enabled him to influence others and imbue them with some measure of his marvellous enthusiasm for science, and he impressed all colonial officials with the importance of seeking every opportunity of discovering the remains of the extinct animals of the regions they visited. Governors, chief-justices, bishops, missionaries, and medical men were alike pressed into the service of science—a Livingstone in Africa, Selwyn in New Zealand, and Vincent in the Mauritius. Men of all ranks responded to his urgent appeals, and owing largely to his importunity our national collections have been greatly enriched by many valuable colonial specimens. Miscellaneous fragments were packed off for his inspection from all parts of the world. Treasuring each part, and remembering every associated fact, waiting patiently, often for years, before the material evidence afforded demonstrative proof of conclusions he had, perhaps, long before arrived at by the inductive method of reasoning which often led him to the conception of creatures stranger and bulkier than zoologists had dreamed of, he has been enabled to recreate, as it were, many remarkable forms. From the New Zealand area he has fully described several species of a giant race of flat-breasted wingless birds ranging from ten to three feet in height.* An extinct coot of large size, and a goose, were added by him to the past fauna of that island whereon Dr. Von Haast has since proved the existence of an enormous bird of prey believed to have lived on the chickens of the Moas, and to have perished on their extinction by the Maories.

In the course of these and similar investigations Professor Owen left many a loose thread to be gathered up in after years and woven into the structure of the extinct animals he was patiently engaged in reconstructing. Of the absorbing delights of such an occupation he speaks vividly in the following characteristic passage from his lecture on "The Extinct Animals of the British Colonies," delivered before the Royal Colonial Institute, May, 1879.* "No chase in the sporting world is so exciting, so replete with interest, so satisfactory when events prove one to have been on the right scent, as that of a huge beast which no eye will ever see alive, and which perhaps no mortal eye ever did behold. Such a chase is not ended in a day, in a week, nor in a season. One's interest is revived and roused year by year, as bit by bit of the petrified portions of the skeleton comes to hand. Thirty such years elapsed before I was able to outline a restoration of *Diprotodon Australis*."

This was the giant kangaroo, with a skull a yard long and elephantine limbs, described by him with many other kinds of marsupials from the tertiary formations of that island-continent, which, prior to the advent of man, was untrodden by animals of higher grades than those of the insectivorous and marsupial mammalia. As Professor Owen's memoirs on the physiological anatomy of the living representatives of the lower pouched mammalian animals were awarded the Copley Medal of the Royal Society in 1846, he was peculiarly qualified to work out the osteological details and general history of the many fossil varieties of the carnivorous, wolf-like, rat-toothed, as well as those of the herbivorous kangaroo type formerly abounding in that region. How some of the larger and unwieldy forms were the first to fall victims to man's pursuit, while the smaller swift-footed escaped longer, with many other interesting facts relating to the origin, structure, contemporary conditions of life, and the physical geography of the island-continent in the past, will be found detailed in his "Illustrated History of the Extinct Fossil Mammalia of Australia."

From the Cape colonies Professor Owen has made known a large number of labyrinth-toothed and theriodont, or "beast-toothed," reptiles. These latter, presenting a remarkable admixture of mammalian and reptilian characters, were discovered in constructing a military road in a Triassic or Permian matrix of a very intractable nature. The structure of this new order of reptiles is fully detailed in his quarto volumes, illustrated with seventy plates, "The Descriptive Catalogue of the Fossil Reptilia of South Africa," published by order of the trustees of the British Museum. He was also enabled to fully reconstruct the osteological framework of the long-sought dodo—the giant ground-dove destroyed by the early French colonists of the island of Mauritius in the seventeenth century—and to add to the knowledge of its ally, the solitaire, of the neighbouring island of Rodriguez.

The sheep-like musk ox (*Ovibos moschatus*), now found only in the Arctic regions, but living in Britain in the glacial epoch, has served him as a text for another osteological sermon. He has also described the cave mammalia of China ("Quarterly Journal, Geological Society," vol. xxvi.), fairly set the great American ground-sloth

* "... Wingless Birds of New Zealand." Illustrated. 2 vols., 4to. Van ...

* Reported in full in the supplement to 'The Colonies and India." May 10th, 1879.

(*Megatherium Americanum*) on its legs again, and restored the huge armour-plated armadillo (*Glyptodon*) of the same continent. From Central Europe he made known the structure of the first-known land-bird, the lizard-tailed *Archæopteryx macroura*, of Solenhofen, and proved Von Meyer's flat-toothed *Placodus* to be a reptile, and not a fish. But it is impossible to note here all his contributions to that history of extinct animals, of which he has given the best summary in the very interesting article entitled "Palæontology," and reprinted from the "Encyclopædia Britannica" in 1869—perhaps one of the best examples of his literary power in popular exposition of technical details. In the course of these long-continued and patient researches he has assembled a vast array of structural facts, throwing many side-lights on the physical geography of the past epochs and on the influences of the *environment*, or conditions of life, as modifying structure—material which has been very serviceable to those working out hypotheses of the distribution of animal life and the origin of species.

It must not be supposed that Professor Owen is the historian only of extinct organisms. Zoology owes almost as much to his labours, for he has investigated the structure of almost every group of living creatures, from man to the parasites infesting his frame.* The urang-utan was the subject of one of his earliest contributions to the Zoological Society, and the gorilla and the chimpanzee were subsequently treated of. He has described nautilus and spirula among molluscs, illustrated not merely the anatomy of the king-crabs among crustaceans, but traced back their genealogy also, and the very footprints of their remote ancestors in the Cambrian sea-floor ("On Protichnites," "Quarterly Journal, Geological Society," 1852).

The mud-fishes of Africa, the *Apteryx* of New Zealand, the great auk of Britain, with the cheetah, the rhinoceros, elephants and whales, and the duck-billed platypus of Australia (*Ornithorhynchus paradoxus*), have alike been laid bare by his scalpel or formed subjects for his pen.

The ant-eater and the little aye-aye (*Cheiromys*) of Madagascar supplied the most striking illustrations for his popular lecture delivered before the Young Men's Christian Association at Exeter Hall, Session 1862–3, entitled "Instances of the Power of God, as manifested in the Animal Creation," at once a powerful and lucid exposition of the great truths of nature, of the author's method of searching out truth, his unwavering preference for the stern logic of demonstrable facts to uncertain tradition, yet animated throughout with the reverent spirit of the religious philosopher, for Professor Owen, while plainly teaching that life came by Law, is no materialist, ever tracing back all natural laws to nature's Lawgiver. Leaning to the Lamarckian rather than the Darwinian phase of the evolutional principle, he has throughout all his works strongly enforced the great evolutional truth of structural modification in adaptation to circumstances of life or the *environment*, but working in harmony with the will of the Creator. The belief in the "Divinity that shapes our ends" pervades all his writings, and is clearly expressed in this concluding paragraph of his work on the "Homologies of the Vertebrate Skeleton": "In every species ends are obtained, and the interests of the animal promoted in a way that indicates superior design, intelligence, and foresight, in which the judgment and reflection of the animal never were concerned, and which, therefore, we must ascribe to the Sovereign of the universe in whom we live and move and have our being."

The value of Professor Owen's services and investigations have not been unrecognised either at home or abroad. In 1856 he received the appointment of superintendent of the Natural History Department of the British Museum. Her Majesty the Queen assigned him one of the royal residences in Richmond Park, and in 1872 honoured him with further recognition by the bestowal of the Civil Companionship of the Order of the Bath. His scientific confrères quickly acknowledged his merits. He was appointed to the first chair of Comparative Anatomy at St. Bartholomew's Hospital, and to the Hunterian professorship of the College of Surgeons. From the Royal Society he received the Royal and Copley medals, and the Council of the Geological Society granted him the Wollaston in 1839. He has been elected honorary fellow of most of the English and foreign learned societies, and is one of the eight foreign members of the Institute of France and of the Medical Academy of Paris; a member of the Royal College of Surgeons, and honorary member of that of Ireland also. The Universities of Oxford, Cambridge, and Edinburgh conferred on him their highest degrees. The Emperor of Germany gave him the Ordre pour le Mérite; the late Emperor of the French the Legion of Honour. From the King of Italy he has received the Order of St. Maurice and Lazare, and that of the Rose from the Emperor of Brazil, who takes a keen interest in scientific matters.

Professor Owen was lecturer on Palæontology at the Royal School of Mines from 1856-57, and Fullerian Lecturer on Physiology at the Royal Institution in 1858. He was President of the British Association in 1857, and at the bi-centennial meeting at York in 1881 presided over Section D (Zoology), selecting for his address on that occasion "The Genesis of the Natural History Museum at South Kensington," a subject which had engaged his serious attention for a quarter of a century with very beneficial results to the nation.

For many years prior to Professor Owen's appointment to the then newly-created post of superintendent of the Natural History Department of the British Museum, Dr. Gray, keeper of the Zoological Department, and the trustees had ineffectually made repeated and urgent applications to the Government for better accommodation for the national biological collections, the available space being totally insufficient for

* His memoir on the *Trichina spiralis* made known a frequent cause of disease, and led to many similar researches, in which Dr. Spencer Cobbold has taken a conspicuous part.

the safe storage, still less exhibition, of the valuable collections entrusted to their keeping, the very considerable annual additions thereto greatly increasing their perplexity. Professor Owen saw at once it was a case for no half-measures. He grappled boldly with the subject, and prepared an elaborate report and plans, in which he showed that a site of eight acres would be requisite for a national biological museum befitting the nation, one that would meet present needs and future contingencies. This, submitted to the trustees, was printed and laid before a select committee of the House of Commons, which reported against the removal of the natural history collections from the British Museum, recommending the extension of the old building, a costly and almost impracticable measure, and one that could afford only temporary relief. But one of the most influential of the elected trustees, the Right Hon. W. E. Gladstone, came to the aid of the baffled and disappointed chief. He minutely inspected the Natural History Departments, saw the difficulties the staff had to contend with in overcrowded cellars and exhibition galleries, and, recognising the justice of the superintendent's demands, moved (May, 1862) as Chancellor of the Exchequer for leave to bring in a bill to authorise the removal of portions of the trustees' collections in the British Museum. The second reading was opposed by Mr. Disraeli on economical grounds, and, although the bill was defended by Lord Palmerston, it was thrown out by a majority of 92 members.

Disheartened, yet not despairing, Professor Owen continued to advocate the claims of the national collections in lectures, the columns of the press, and in the reports he annually submitted to the trustees. In an able pamphlet issued at this period, on "The Extent and Aims of a National Museum," he justified his views, unjustly criticised and even ridiculed by some members of the House of Commons, in the press, as well as by those of his scientific contemporaries inclined to the idea that a selection of animal types illustrating the different groups of the animal kingdom was all that was necessary for a national museum. He strongly combated these views, and showed it to be incumbent on the Government to provide fitting exhibition space for the collections bequeathed to the nation or purchased on its behalf out of national funds. He urged also that every biological branch should be represented, and that special efforts at least should be made to procure specimens of the many bulky species yearly becoming rarer through the onslaughts of man and the inroads of colonisation, all of which ought to be preserved, ere it became too late, in a national museum, which should further contain remains and representations of all the creatures that formerly lived on the earth.

In 1863 Mr. Gladstone brought in another bill, authorising the purchase of five acres at South Kensington, which after long debate was carried by a majority of 132 in a house of 267 members. It was again through Professor Owen's representations of the needs of posterity that eight acres were ultimately secured of the old Exhibition site in Cromwell Road, South Kensington. Thus ended the first stage of a stern campaign, with the site for a new Natural History Museum as the first-fruits of victory.

This great step in advance was followed by Professor Owen's invitation to Hawarden, to discuss plans in detail for the projected edifice. His suggestions were placed by Mr. Gladstone in the hands of Sir Henry Hunt, of the office of Works, and formed the basis of those adopted for the present building ultimately erected after a very long interval. In 1867 Lord Elcho raised an unsuccessful debate on the subject, and it was not until 1871 that the first grant of £40,000 was voted for the erection of the building. In spite of occasional demurs on the part of the economic section of the House, the work proceeded slowly, with the result that a National Natural History Museum, covering four out of the eight acres of the secured site, and providing three times the accommodation of the old building, was, with the single exception of the lecture hall, erected in entire conformity with the views of the superintendent just twenty years after their first rejection as utterly utopian. Thus, thanks chiefly to Professor Owen's influence and unceasing efforts and foresight, our national biological museum may claim to rank, as it should do, as the first in the world, containing within itself the possibilities of attaining that high and exemplary standard of excellence, richness, and instruction which befits our position among civilised nations.

In 1853 Professor Owen married Miss Clift, the daughter of his predecessor in office as Conservator of the Museum of the College of Surgeons, by whom he had one son, who has not evinced any marked predilection for the natural sciences. A widower for some years, the veteran scientist has resided in the quaint and picturesque cottage in Richmond Park, granted him as a life residence by her majesty the Queen, to whose younger children he at one time gave instruction in natural history subjects. There, in the intervals of his scientific labours, Professor Owen cultivates roses and the acclimatisation of trees from higher altitudes. A brief sojourn in a warmer climate has been occasionally requisite. One winter he received a royal invitation to accompany the Prince and Princess of Wales on their Nile voyage. Royal personages, scientific, literary, and artistic celebrities of many nationalities, make the pilgrimage to the home of England's great comparative anatomist. Although close on eighty years of age, he is comparatively hale and vigorous, and working still. Among his latest publications are a description of a nine-horned land-lizard he has added to the known tertiary fauna of the Australian continent, and a Guide to the Bird Niche of the Index Museum at South Kensington, the only one of a series as yet completed, designed by him to illustrate the structure, affinities, and history of each group of the animal kingdom, and to serve as an epitome of the general collections, to the full comprehension of which they would afford the best introduction.

In the course of a long, laborious, and useful career, Professor Owen has necessarily been

brought in contact with many of the most remarkable men of all ranks of society. His manners are characterised by the genial warmth and courtliness of the old school. A *raconteur* by nature, no one knows better how to develop the point of the many good stories his life experiences furnish. His powers as a popular exponent of scientific detail will not readily be forgotten by those who have listened to his familiar addresses on Saturday afternoons to working men, or some favoured metropolitan association of scientific students in the old British Museum. We can see him, big bone in hand, his tall frame and broad shoulders dominating the circle, and his kindly face beaming with intellect, as he sketched the structure and habits of the extinct creature of which it once formed part, picturing with vivid force its associates and surroundings, and carrying the eager circle of listeners with him as he demonstrated how the animal lived and died, leading them on to a comprehensive survey of the physical geography of the continents in long past epochs, to a right conception of which in their biological aspects he has so largely contributed by his life-long researches.

COURTS OF JUSTICE IN BRITISH INDIA.

BY THE AUTHOR OF "MY BOYHOOD IN THE EAST.

II.—LAWS OF EVIDENCE.

MANY of the most vivid of my recollections of my boyhood relate to the trials of prisoners.

I have already stated that it was my father's practice to be present when the assizes opened, and that I was usually with him to hear the charge to the grand jury. Nothing more deeply interested me than the proceedings which followed. The court-house was close to the "free-school" in which I was a scholar, having as companions and competitors boys belonging to almost every race and religion in the East. A proud day it was when the then Governor-General of India visited the school, and gave me and others our prizes. I could fill pages with descriptions of criminals and crimes, and I am sorry to add that more than once I managed, without the knowledge of the home authorities, to be present at awful scenes of public execution. I remember being astonished by the strict observance of the very technicalities of the laws of evidence. The entire crew of a boat had been seized and committed to prison for trial as pirates. They belonged to a district notorious for piracy; in the boat and upon their persons were found the arms used by pirates; everybody knew them to be such; and yet because no one could swear to any act of piracy, and they told a good story in explanation of the circumstances in which they were discovered, they were set free! I have never forgotten the lesson thus taught me honestly and impartially to deal with every question to be considered, whatever the results might be.

I remember I used to watch with rapt interest the administering of oaths. Some of the methods were very remarkable, and I was always eager to see the various witnesses sworn. The Christian, whether Protestant, Roman Catholic, or Arminian, would of course kiss the Testament. But there was the Mohammedan, sworn by the usual invocation of Bismíllah, er Rahmán, er Rahméen ("In the name of God, the Compassionate, the Merciful!"), with the sacred Kurán, wrapped in cloth, placed by the attending moollah (mosque official) in his extended palms; the Hindu, by fixing his eyes on some water in a small brass vessel placed in like manner by his guru (family priest), containing water which did duty as Ganga-pani (water of the Ganges), inasmuch as some muntras (prayers) had been pronounced over it by a Brahmin; and the Chinaman, who was sworn by burning at a taper a narrow strip of paper on which were written "characters" containing, as I understood, an appeal to his deceased ancestors. I have the impression that the Parsee when dealing with Parsees, also swears by fire; but in a British Court he is put upon his oath by kissing the Zend-Avésta, his sacred book.

I am not sure, but I believe I am right in saying that I also occasionally saw a man put on his oath, as is done among the hill tribes of India, by crushing in his hand a leaf from a tree sacred as the dwelling-place, among its branches, of sylvan deities, who are thus invited to crush him and those belonging to him should he speak anything but the truth.

These reminiscences belong to the Straits of Malacca, but there is now throughout India proper one established form of legal oath. This arrangement is based on the assumed fact that in all its religions there is recognition of a supreme deity. With the more intelligent Hindus it is well known that the multitudinous divinities acknowledged are really but various forms of the one and only God—Isvara or Deva. The oath differs however, in the form of its commencing attestation. All persons professing Christianity, whether natives or foreigners, "swear," while others "solemnly affirm." The following is the oath: "I

UNIVERSITY MAGAZINE, 1878 WOODBURY MECHANICAL PROCESS

Yours faithfully,
Richard Owen

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strengt… Imper-
through… in the
through… e light
charact… ey are
with th… nphibi-
to rise, … terious
abunda… . They
Thos… ose in
still the… and in
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sobriety… mpling
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we thin… his we
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well co… n than
they a… ed.
are in a…

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Richard Owen

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CONTEMPORARY PORTRAITS.

NEW SERIES.—No. 3.

PROFESSOR OWEN, C.B., M.D., D.C.L., LL.D., F.R.S.

How rarely, after all the opportunities that education puts before men for the advancement of science, do we find anyone sufficiently endowed with the art of acquiring that preliminary knowledge of conventional details without which no speculation, no deductions, no theoretic results are of any practical value. But when the divinely nascent master mind, thrilling with the consciousness of future greatness, has grasped the necessary rudiments of those branches of human learning and research which best apply towards the realisation of its advanced mission, and, so progressing, ultimately reaches a point where, with

> Nothing before, nothing behind,
> The footsteps of faith
> Tread on the seeming void, and find
> The rock beneath—

How great the glory of the man who, having arrived at this culmination of scientific attainment, is there sustained by the satisfaction that it is through his individual cultivation that permanent good is transmitted to his fellows, who, had it not been for his labours, might have failed ever to discover such benefits for themselves! These sentiments apply in a great and peculiar manner to him whose portrait adorns this number of the MAGAZINE, the third member of that triad of scientific naturalists which numbers Linneus and Cuvier as its two other members.

Richard Owen is the youngest son of Richard Owen, Esq., of Fulmer Place, Bucks; he was born at Lancaster on the 20th July, in the year 1804. His early years were devoted to the ordinary studies of youth at the grammar school of his native town, where he was contemporary with Whewell, and in 1824 he passed his matriculation at the University of Edinburgh, where he attended the anatomical

lectures delivered by Dr. Barclay. He also spent a considerable period attending the Schools of Medicine in Paris, and was a pupil of the illustrious Cuvier, whose labours in Fossil Osteology Professor Owen has so closely followed up. Two years later, after successfully passing his medical examination in London, he became a member of the Royal College of Surgeons of London, and in 1827 he commenced life as a surgeon in private practice in Serle Street, Lincoln's Inn Fields. Even at this early period of his career he was ever on the watch for the advancement of science. and he was enabled, by his careful practical researches, to communicate several important cases to the Medical Society of St. Bartholomew's Hospital, of which he was a member. It was also about this time that he demonstrated the practicability of tying the internal iliac artery, an operation which had attracted the attention of the profession in connection with a well known case of aneurism of the gluteal artery.

At the recommendation of the celebrated Abernethy the appointment of Assistant Curator of the Hunterian Collections was conferred upon Mr. Owen, and this office first diverted his attention from general medical practice to the crowning object of his life, the pursuit of comparative anatomy, a science at that time far from being accurately studied or properly worked out. This appointment induced him to resume his zoological labours, and he threw himself with ardour and energy into the performance of a task admirably fitted, as the result indicated, to call forth and develope those powers of research and observation which have so extensively conduced to his reputation. Among the first great works which he undertook was that of preparing a "Descriptive and Illustrated Catalogue of the Specimens of Physiology and Comparative Anatomy" in the museum of the College. This work was published in five volumes quarto. He also prepared the catalogues of Natural History, Osteology, and of Fossil Organic Remains preserved in the same museum. These works were received at the time with great success. as an important and very necessary contribution towards the scientific literature of England. In the preparation of these publications much was required to be performed, and Mr. Owen, as curator, applied himself with the greatest diligence to the dissection of such animals as the Zoological Society of London could supply from time to time. Thus he obtained materials for many valuable contributions to the Proceedings of the Society, while the same facts were also available towards the illustration of the Hunterian Catalogue, the first portion of which appeared from the press in 1833. In 1834 a second, and in 1836 a

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third portion was issued, but four years elapsed before the production of the remaining volumes, which are generally considered to contain perhaps the most interesting portion of his work.

In the year 1834, Mr. Owen was appointed to the Chair of Comparative Anatomy in St. Bartholomew's Hospital, and here he numbered among his pupils, who were destined to become distinguished at a future day, Dr. Rymer Jones, Dr. Arthur Farre, and White Cooper. In the course of the following year he married the only daughter of his friend and colleague, William Clift, Esq., Curator of the Hunterian Museum.

In the year 1835, Professor Owen was appointed Hunterian Professor and Conservator of the Museum of the Royal College of Surgeons. He was actively employed as a Member of the Commission of Inquiry into the Health of Towns, as well as of the Metropolis; taking a prominent part in all the great questions of the day, and especially devoting himself to the appointment of the Commission of Inquiry into the State of Smithfield Market. It is believed that to Professor Owen's perseverance in ventilating the evils of this great centre of nuisances, the inhabitants of London are principally indebted for the removal of the Market. As an instance of the remarkable way in which Professor Owen was accustomed to deal with new facts, it may be mentioned that in 1835, Mr. Wormald, of St. Bartholomew's Hospital, transmitted to him a piece of flesh in which he had discovered a new entozoon, chiefly interesting to the sender as a mere curiosity of science. It was pointed out by the Professor to be the now too well known and dreaded *Trichina spiralis*, which has since been found to infest the human muscles, sometimes to such an extent as to cause death from the pain and inflammation attendant upon the development of numbers of these minute internal parasites. It is this organism which has produced the epidemic *Trichinosis*, which made fearful ravages in Germany, and its propagation has been demonstrated to be principally brought about by the consumption of raw and diseased pork.

In the year 1836 Professor Owen was elected a Fellow of the Royal Society, and on the retirement of Sir Charles Bell, to the Professorship of Anatomy and Physiology in the College of Surgeons; he also undertook to deliver lectures on the contents of the Hunterian Museum, which were continued by him down to 1855. His work on Odontography was produced in 1840-1845, consisting of two quarto volumes, in which is contained a comparative investigation of the differences in the microscopical structure of the teeth of every class of animals. His

description of a Belemnite from the Oxford clay was honoured by the Royal Society with the Royal Medal.

After devoting a considerable part of his life to the elucidation and illustration of the labours of John Hunter, Professor Owen resigned in 1856 the curatorship of the Hunterian Collection, and was appointed by the Trustees of the British Museum to be Superintendent of the Departments of Natural History. This post, which involves the superintendence of the three great branches of Zoology, Geology, and Mineralogy, Professor Owen still retains, adorning by his extensive and comprehensive knowledge of the subjects specially characteristic of these departments, a position which naturally, from the great responsibility which attaches to the office, is one of very great distinction: one, in fact, which has never been bestowed on anyone before. On the state and advancement of these great departments he has made, in his capacity as Superintendent, many reports, which will be found printed in the annual returns to the House of Commons. It has been considered by him, judging from the estimated numbers of known specimens of natural history and the ratio of additions in past years, that adequate space for the exhibition of the several species would require a building covering as large an area as two acres and a half, while to be prepared for future extensions a greater amount of room would be required. The new buildings at South Kensington, which are in a very forward state of erection, will probably be found amply sufficient to meet the views of Professor Owen, but it would perhaps be impossible to determine the point until we are able to see the objects themselves arranged in their new, and let us hope final, resting place.

In 1851, Professor Owen directed his energies to the organisation of the Great Exhibition, and as President of one of the Juries, his services were of great value towards the success of that speculation.

The Commissioners of the Exhibition of 1855, at Paris, also availed themselves of his services in a similar manner; his journey to the French capital on that occasion being undertaken at the request of the Government. In that year one of the greatest works of Professor Owen was published, viz., "The Principles of Comparative Osteology," in French. In 1866-68 he published his "Anatomy of the Vertebrates" in three volumes, richly illustrated. Professor Owen was one of the founders of the Microscopical Society and first occupied the presidential chair. He was also President of the British Association at the Leeds meeting, 1857. Among the foreign distinctions which have been conferred on him are the dignity of Chevalier of the Order of Merit of Prussia. He is also

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one of the eight foreign correspondents of the Institute of France, and has received from the Emperor of the French the Order of the Legion of Honour. The King of Italy conferred upon him the Order of St. Maurice and St. Lazare. The King of the Belgians, and the Emperor of Brazil have also decorated Professor Owen with orders; and Her Most Gracious Majesty accorded to him the privilege of a residence in Richmond Park, and the title of Companion of the Bath.

As an example of the fertility of the brain of this most indefatigable of modern scientific pioneers, it may be interesting to know that for very many years of the present century Professor Owen has contributed unceasingly to the Journals and Transactions of a large number of societies, among which may be specified the Royal, Linnean, Geological, Zoological, Cambridge Philosopical, Medico-chirurgical, Odontological, and Microscopical Societies. There are also some elaborately prepared reports on "British Fossil Reptiles," from his pen in the Transactions of the British Association, the "Annals and Magazine of Natural History," and the "Geological Magazine."

Among his latest works we may mention a "Description of the Fossil Reptilia of South Africa," 1876, in quarto, published by the Trustees of the British Museum; his "Researches on the Fossil Mammalia of Australia, and Fossil Marsupials of England," in two volumes quarto, 1877. Professor Owen is also about to issue his great illustrated work on "The Extinct Wingless Birds of New Zealand."

But the catalogue of works by Professor Owen would somewhat tire the patience of our readers. The new catalogue of printed books in the British Museum contains upwards of sixty entries relating to works published by him, among which are several general essays, as, for example, a discourse "On the Extent and Aims of a National Museum of Natural History," wherein the necessity of a great collection of specimens, arranged in the most liberal manner as regards classification and spacing, is set forth; and another discourse of the most instructive kind is that entitled "Instances of the Power of God, as Manifested in His Animal Creation." The gorilla, the dodo, the aye-aye, the pearly nautilus, the ornithorhynchus, the megatherium, the wingless birds of New Zealand, and many others of the most striking objects of the animal kingdom, have been noticed and described by Professor Owen, in that wonderfully clear, acute, and forcible language which he has so readily at his command. But it is chiefly upon his researches into the marvels of palæontology that his fame rests.

For to few has it ever been given, and to none in a more happy and

fortunate way than to him, to re-create, if we may use such a word, or at any rate to reconstruct out of the slenderest and apparently most insufficient data, the denizens of our antediluvian earth. How many creatures has he not rehabilitated and built up for us from the merest fragments of their skeletons? The contemplation of a fragment of a thigh bone from New Zealand has led, when passed through the crucible of his inductive thought, to the restoration of a gigantic bird eleven feet in height, or about double the stature of an ordinary mortal. The well known but once mysterious fossil Belemnite, in his hands takes its proper form and place in the order of *Cephalopoda;* in a word, from Professor Owen's expositions, the dry bones of bygone æons become re-instinct with life, and the uninteresting intricacies of comparative anatomy become endowed with an all-absorbing interest and fascination which few can withstand, in order that—as Quintilian so neatly expresses himself—"*quantum ad cognitionem pertinet rerum, etiam praeteritis saeculis vixisse videamur.*" To read aright the history of the world in its oldest phases, in its most mysterious aspects, and from its deepest scientific points of view, the manifold works of Professor Owen must be taken in hand and studied with patience; and the reward to the mind of the reader, as far as enlightenment of the grandest and most instructive kind avails anything, cannot fail to be proportionate to the amount of time and consideration given to the perusal of his great practical lessons to us upon our position in the cosmos of infinity.

W. DE G. B.

UNIVERSITY MAGAZINE. 1878

Yours faithfully

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THE RIVER'S ROMANCE.

Once upon a summer day—
With a hey and a ho down derry—
A minstrel wandered on his way,
And thus he sang his joyous lay
By the river side so merry:
Singing to the singing river,
"River, River,
Sing for ever:
Let my life flow like thy stream
All a sunny summer dream."

Down the stream there stole a maid—
With a hey and a ho down derry—
Beneath a drooping willow's shade
Where the moaning waters darkly strayed,
And thus she sang so dreary,
Singing to the murmuring river,
"River, River
Why for ever
Flows my life in sorrow still
Like thy waters dark and chill?"

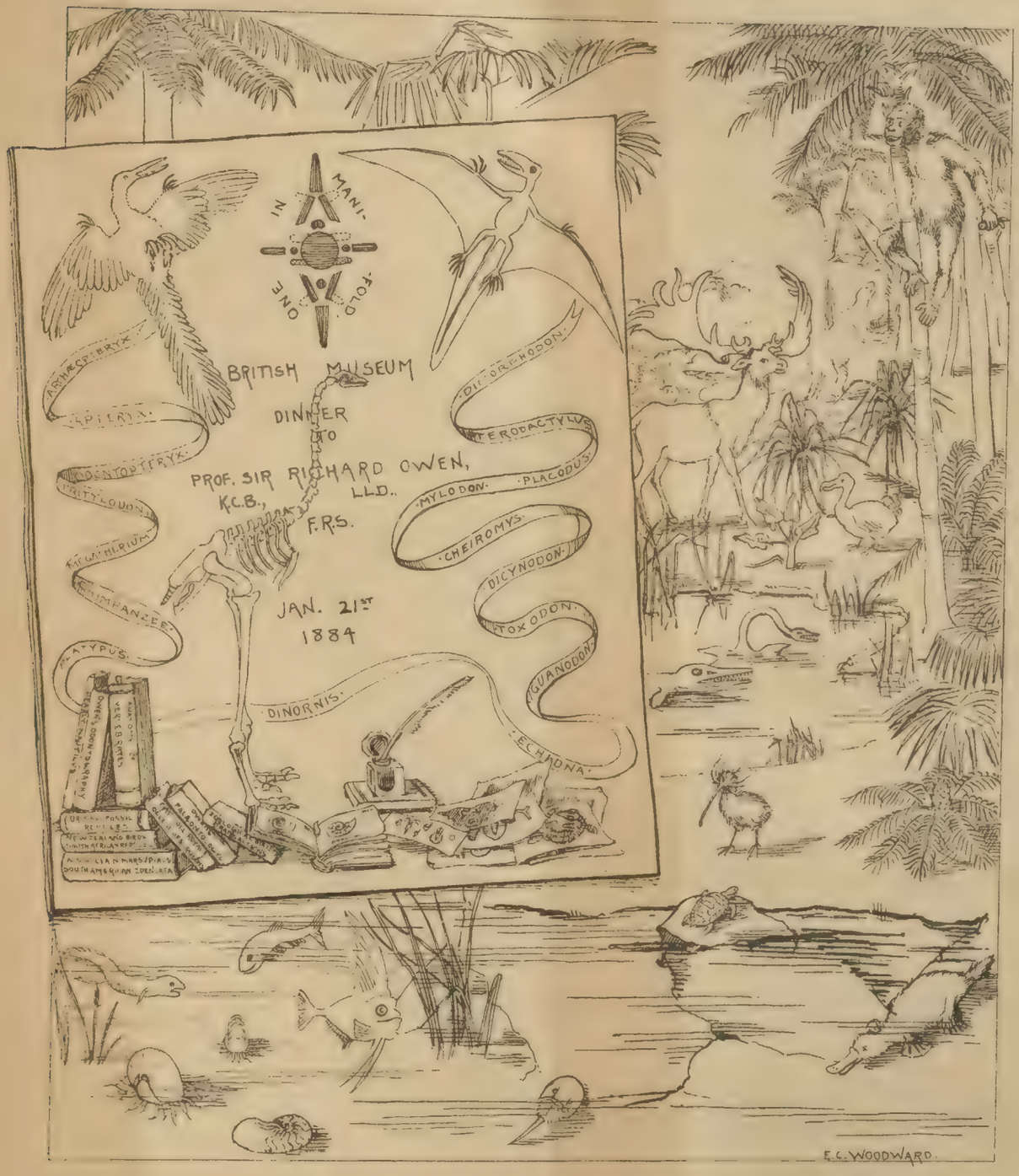
The joyous minstrel tripped along—
With a hey and a ho down derry—
The welkin echoed to his song,
Until he came where, the boughs among,
The maiden sat so dreary,
Sighing to the sighing river;
But the river
Flowed on ever,
Heard the sigh and heard the song
And, heeding neither, flowed along.

The minstrel looked upon the maid—
With a hey and a ho down derry—
His hand upon the boughs he laid
And drew aside the willow's shade
And let in the sunlight cheery:
Singing to her by the river,
"Life's a river
Changeful ever.
Into the sunshine come with me
And both our lives shall happy be."

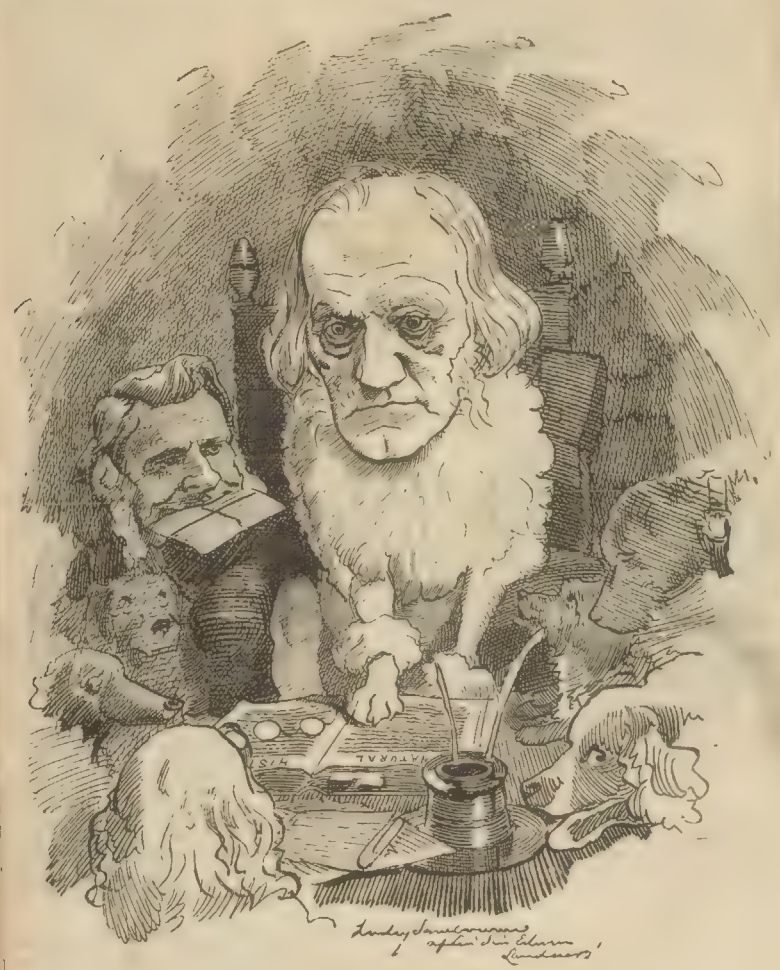
The public will learn with unfeigned regret that PROFESSOR OWEN has resigned the post of Superintendent of the Natural History Departments of the British Museum, which he has held with so much distinction for more than a quarter of a century. At the advanced age of eighty years a man may well consider that he has earned the right to withdraw from active occupation, and the good wishes, not merely of Englishmen but of the whole scientific world will accompany the learned Professor into his well-earned retirement. PROFESSOR OWEN's reputation was fully established when the present generation was still in its childhood, and though no science has made greater advances than that to which his life has been devoted, he has maintained his place among its leaders down even to the present day. In pure biology he may have been surpassed by his juniors, but in palæontology and comparative anatomy his name must be reckoned among the greatest. Not only have his untiring researches added largely to our positive knowledge of the animal kingdom, both extant and extinct, but he has contributed to the theory of his science ideas of the first importance. In his celebrated work "On the Archetype and "Homologies of the Vertebrate Skeleton," he worked out with profound insight and comprehensive knowledge the *idée mère* first propounded by LORENZ OKEN as to the development of the vertebrate skeleton from primordial elements framed in accordance with a single archetypal form. Armed with this fruitful idea, he surveyed the whole animal kingdom, and shed upon it the brilliant light supplied from a singularly original and well-stored mind. It is impossible here to enumerate his enormous labours in the field of comparative anatomy and cognate regions or fully to characterize their main results; but it may, perhaps, be said that his peculiar and distinctive eminence has lain in the domain of what may be called reconstructive anatomy. Anatomy is commonly regarded as a science of pure observation; in the hands of PROFESSOR OWEN it has lent itself to actual discovery in regions which lay beyond the limits of direct observation. By a combination of rare speculative insight with profound knowledge of animal structure, he has been enabled to reconstruct the anatomy of extinct animals from the obscure and imperfect indications afforded by a mere fragment of the skeleton. From a single tooth or a single bone he has been able to infer the complete structure, and to reproduce it with a force of scientific conviction little short, if at all, of direct and positive proof. It is possible that in dealing with such questions as now perplex and divide biologists PROFESSOR OWEN, who is a naturalist of the pre-Darwinian epoch, may be regarded by some of his junior contemporaries, who have sat at the feet of more adventurous teachers, as somewhat behind the age. But all his contemporaries will acknowledge, and the most eminent of them most readily, that his place is among the foremost of those who have illustrated science and advanced its pursuit in England.

It is not merely in the domain of pure science that PROFESSOR OWEN has earned the respect and esteem of his contemporaries. His public services in the practical sphere have been various and remarkable. As a sanitary reformer and an authority on the health of towns, he did excellent work in what may now be called by comparison the pre-sanitary times, and his rare administrative capacity has been shown in his organization of the Museum of the College of Surgeons and of his own department at the British Museum. The Hunterian Museum is almost his creation in its present form, and the Natural History Museum at South Kensington is largely the result of his initiative and organizing power. No work such as his is ever done without a certain amount of friction, and it is possible that his colleagues and subordinates may at times have found it difficult to hold their position against the weight of his enormous authority and experience. However this may be, there is no one but will acknowledge the value of his public services and the splendour of his scientific achievements. That such services and such achievements abundantly establish the claim of PROFESSOR OWEN to such titular honours and public marks of distinction as he might care to accept is a reflection naturally suggested by the announcement that the POET LAUREATE is to be raised to the peerage and that baronetcies have been conferred on two eminent and highly respected members of the medical profession. It is likely enough that the venerable old man whose fame has been established among his countrymen and throughout the world of science for more than a generation may care for no higher distinction than that well-earned fame confers. But we are satisfied that we only give expression to the general voice of the nation when we say that if honours and distinctions were acceptable to him there is no one who would be held to have better deserved them than he.

The announcement that baronetcies have been conferred on MR. BOWMAN and MR. LISTER will be received, we doubt not, with general and keen satisfaction. It is a compliment to a great and noble profession and a fitting recognition of the long and eminent services of two men who, each in his special department, have sustained and enlarged the unrivalled fame of English surgery. MR. BOWMAN's reputation has so long been established beyond dispute that though still in the active practice of his profession he may almost be regarded as *emeritus*. MR. LISTER is a younger man in years than MR. BOWMAN and younger still in the practice of his profession in London, but it is not too much to say that his teaching and example have effected something like a revolution in surgical practice. Medical men are for the most part stanchly conservative in professional matters. In his antiseptic treatment of surgical cases MR. LISTER has had a vast amount of opposition to encounter, and not a little dissent, contempt, and even ridicule to live down. But his innate force of character and his sturdy confidence in the efficacy of his methods have carried him through, and the public recognition of his eminent services implied in the honour now to be conferred upon him is only the counterpart of the esteem he has conquered among the members of his own profession. Turn where we will in fact we encounter signs that achievement of any kind in the intellectual sphere is becoming more and more assured of its appropriate recognition and reward. At one end of the scale we find such encouragement given to technical education as is implied in such a meeting as that of yesterday, where the LORD MAYOR and the PRESIDENT of the ROYAL SOCIETY lent their countenance to the youthful but vigorous City and Guilds of London Institute. At the other end we find a peerage conferred on the POET LAUREATE with the unanimous acclaim of the whole English speaking race. Peerages conferred on purely literary grounds are undoubtedly a constitutional innovation. But a precedent once set is more likely to be followed in England than a dictate of pure reason, or even a mandate of the popular voice. Whether the real honour is conferred on the House of Lords or on its junior Baron is a question for casuists, political and literary. But there is no doubt the House of Lords will gain in national esteem, while there is no reason why it should lose in political strength, if it should be found possible to graft an Academy upon it.


IN MANI-
FOLD ONE
BRITISH MUSEUM
DINNER
TO
PROF. SIR RICHARD OWEN,
K.C.B., LL.D.,
F.R.S.
JAN. 21st
1884
ARMADILLO
APTERYX
DINORNIS
PTERODACTYLUS
MYLODON
PLACODUS
CHEIROMYS
DICYNODON
TOXODON
IGUANODON
ECHIDNA
PLATYPUS
E.C. WOODWARD

PUNCH'S FANCY PORTRAITS.—No. 169.



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Sheen Lodge, Richmd. Park, E. Sheen.
12th. January, 1884.

My dear Woodward,

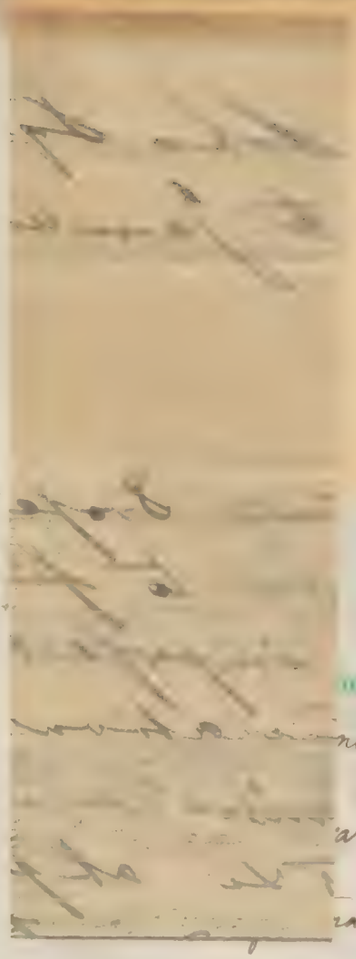
I write to say, lest I should fail to be with you on Monday, that I accept the offer of £250.0.0 for the books & pamphlets, as estimated by Mr. Dulau.

Richard Owen.

Enniskillen writes to ask if I can procure for him Photos. of

Edward Forbes
Dean Peacock
Leonard Horner
Dr. Buckland
Wm. Jno. Broderip.

Of



nuary, 1884.

ard,

ate to catch a Train
just on the move for Northlakes, found
my Cab in waiting, and got comfortably
home to anxious Sister before 10. p.m.
I shall always feel your Debtor
for the great & unexpected pleasure
of last memorable Evening! But
you know what is the ground

of

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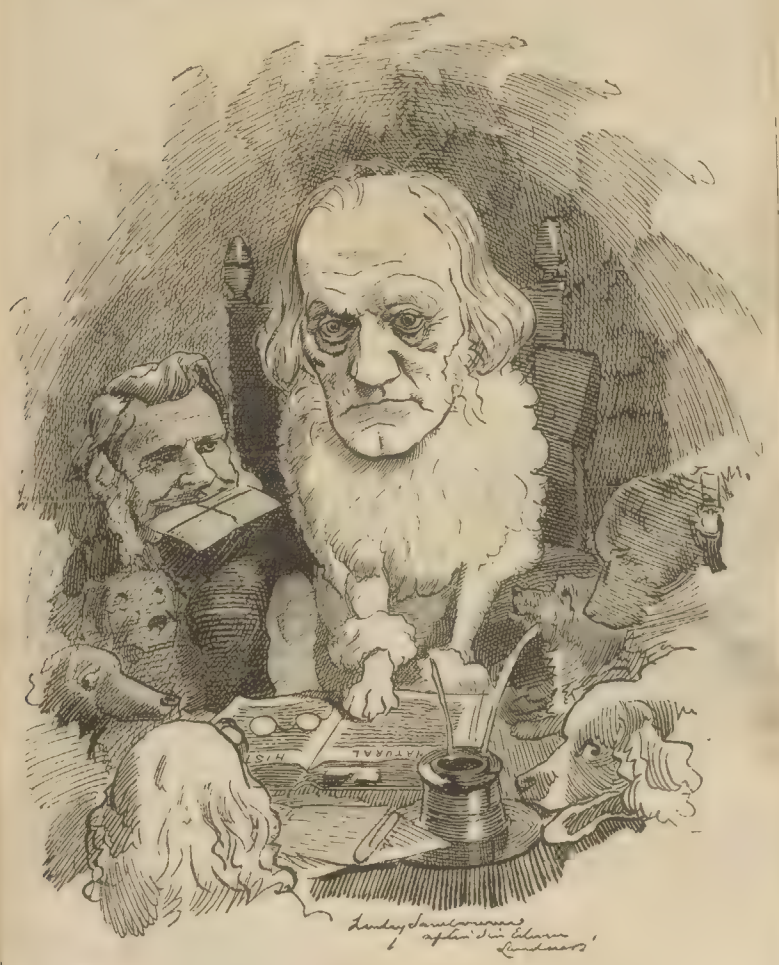

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of the last I think Arthur Barre took a photo- years ago in my garden, W.I. if I can find or get I will send to Florence Court.

I have not one of any of the others. Any help from you in Boat matter will be gratefully felt by "My Lord", and by,

Yours always truly,

Rich. P. Owen.

My will was in doc, not retain either the amount or the name of the worthy Estimator, please to add both.

nuary, 1884.

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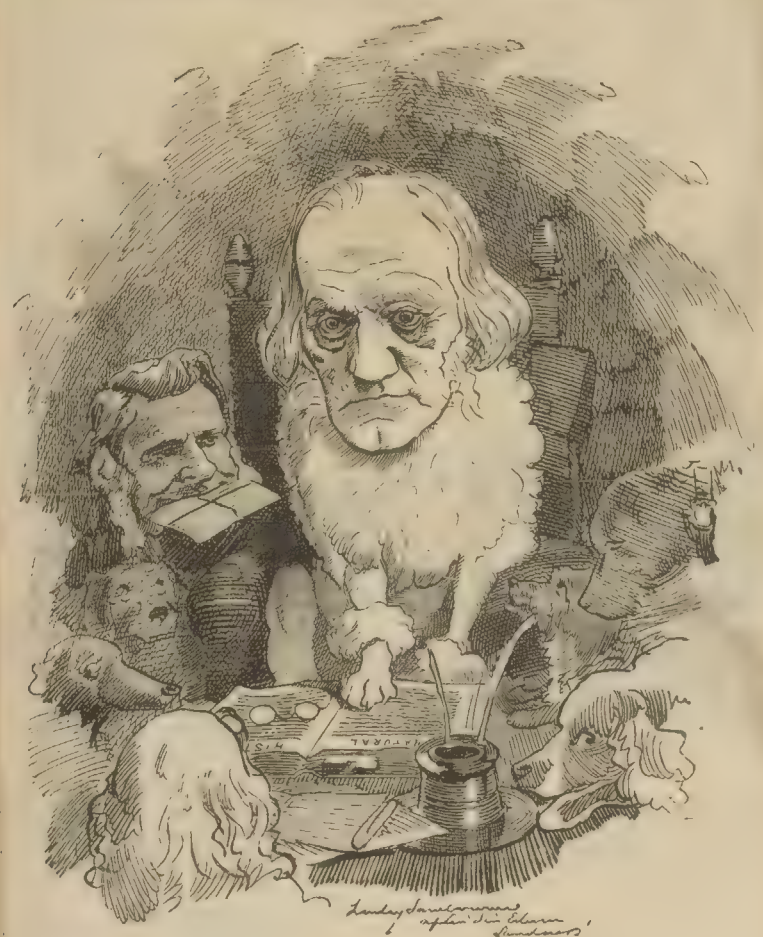

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37 Soho Sq
1st January 1884

R. H. Woodward

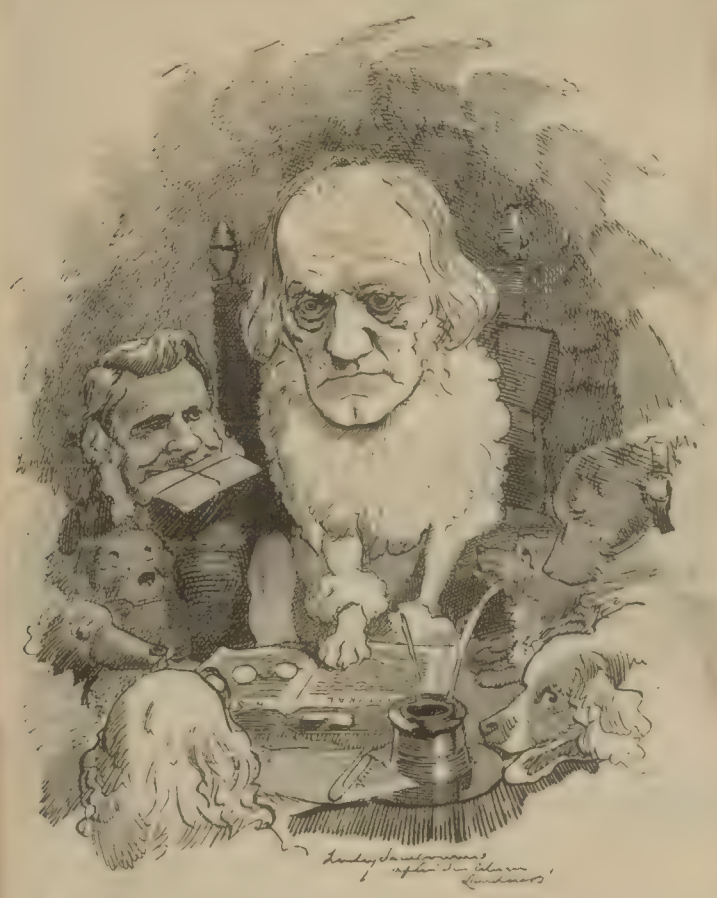
Sir,

I have examined Professor Owen's books and regret to find that all the serials are imperfect, taking this into consideration, I offer £250 for all the miscellaneous works, books, pamphlets &c at present in Mr Etheridge's study and in Geological room, excepting the Professor's own publications which must be treated with separately

Yr obt svt

F Justen
Butcher

PUNCH'S FANCY PORTRAITS.—No. 169.



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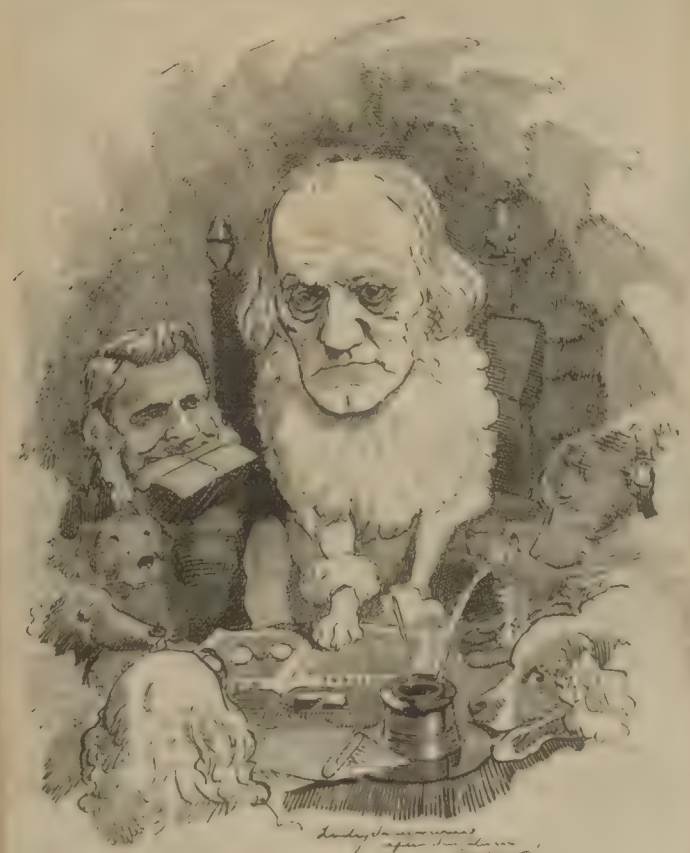

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of asking 'future favours'.

D^r Enniskillen has written to retire & should desire his health on Friday, 25th when he achieves his 77th birthday.

Vaux promised me he would join me at dinner that day and if you could, without inconvenience come, there are no two friends which His Lordship would be more pleased to hear

of, as joining me, on that occasion.
I propose 6 p.m. for the dinner
hour, but would change it
on notification from you.

My Cab will call for V. and you
at 9.40 p.m. when a train for Vauxhall
& Waterloo starts at 10 p.m. But there
is an earlier train at ~~9.45~~ 9.35 & 9.50, also
stopping at V. hall, & reaching Waterloo
at ~~9.52~~ 10.33 and 10.2. The Cab shall call at
the time most convenient to you
both. If you should come 'down'

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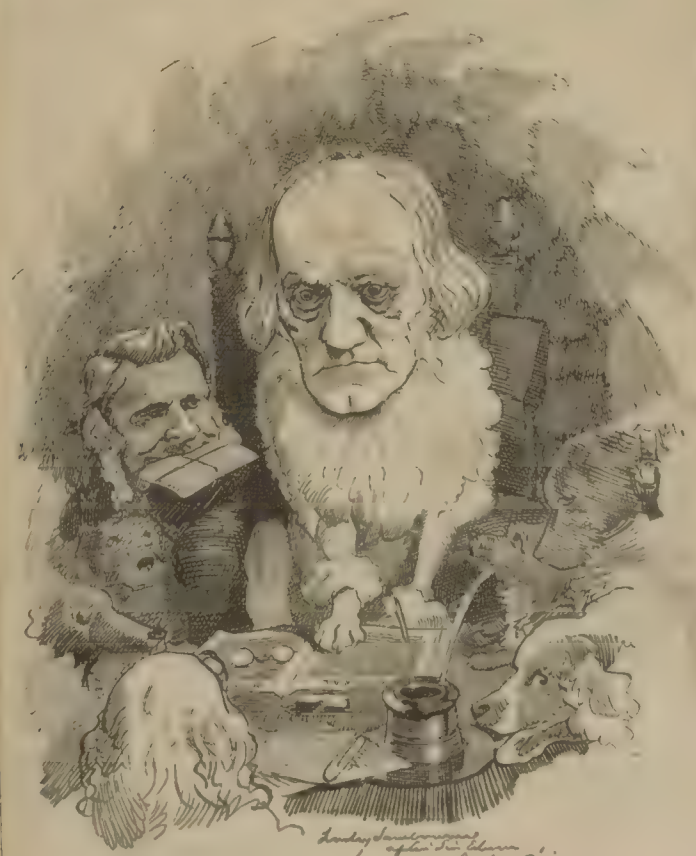

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together, by the 5, ~~o'clock~~ 12, p.m. Train
or the 5. ~~2~~ 38 p.m. from Waterloo
also calling at Vauxhall, ——
a Cab at Northlake would be
engaged to bring me at once to
my gate. I hope you may
be able to arrange this with
Vaux.

A line to let me know
will oblige, Yours ever,
Richd. Owen.

My best thanks & the Article of
the Carte!

to graft an Academy upon it.

29 November 75

Dear Mrs Woodward

The small degree in which my name may be known, beyond the circle of Palæontologists, depends so exclusively on crabbed Scientific grounds, that I must reluctantly forego the opportunity which your kindness prompts you

CROMWELL ROAD,
SOUTH KENSINGTON,
LONDON, S.W.

7th October/81.

Dear Dr. Woodward,

If this weather should hold would you & Mrs W. & your flock be free & disposed to dine with my Sister & me on Sunday*. If so, let me frank you to Sheen Lodge - Get a Carriage & Pair, & Cat then

*"flock" of 3 eldest to go with us. The rest to wait till next summer.

SELDOM has the honour of knighthood been conferred more worthily, or with a larger measure of public approbation, than upon Professor OWEN. The distinction, perhaps, has come somewhat tardily; but its bestowal now coincides with the moment of the retirement of the illustrious octogenarian from the active duties of his post as chief of the British Museum of Natural History, and is, therefore, felicitously opportune. Yet, after all, knighthood or no knighthood, the great Professor has his monument and perpetual memorial in that superb edifice at South Kensington, that temple to Nature, which the nation owes in great measure to his unflagging enthusiasm and his determined advocacy. A quarter of a century has elapsed since Sir RICHARD OWEN first urged upon the Government the necessity for the new Museum; and, though the scale by which he guaged his requirements and the totals in which he summed up the necessary expenditure were such as to appal the guardians of the public purse, yet science, working for the national good, had its way at last, and persistent counsels their ultimate triumph. Fortunate, therefore, beyond many who have laboured with the same single-minded energy towards a special object, the youngest of our Knights of the Bath has lived to see his ambitions completely realised, and to know that nothing now can prevent London from possessing the grandest museum for the study of natural history that the world possesses. As the founder of the British School of Comparative Anatomy, as the author of works of unique value, as the chief of palæontologists, he has laid the whole world under a common obligation and taken rank with those organising master-minds of science, LINNÆUS, CUVIER, and DARWIN. As the most courageous of the champions of public interests, and in insisting upon having the new Museum built—and built upon a scale worthy of its purpose—as the most indefatigable of superintendents, he has earned the gratitude of his own country in a degree that seldom falls to human good fortune. Not that the old professor is lost as the new knight to South Kensington. For his rooms remain there just as in the past, and the venerable figure, that all who work under him have learned to greet with an almost affectionate respect, will still be familiar in the old places to the staff and to visitors. The burden of the day may well fall now on younger shoulders, but South Kensington cannot yet spare its NESTOR, nor science afford to let him take that rest which his honourable years might claim.

Whoever it may be that takes Sir RICHARD OWEN'S place, he will succeed to a position which the labours of his predecessor have already lightened of much of its original burden. A vast amount of hard work, it is true, yet remains to be done, and work that will require for its successful accomplishment the highest order of administrative ability, and an intimate acquaintance with both the scheme and the details of the practical working of the several departments. Though everything has been set going, and has received its initial impulse from the retiring chief, it is all-important for the future of this great national institution that there should not yet be any deviation from the lines upon which its foundations are laid, and that for some years, at any rate, the hands and heads Sir RICHARD OWEN has himself trained should have the guiding of it. The original scheme, however, the large, far-seeing plans upon which the Museum was at first laid down, were virtually Sir RICHARD OWEN'S work. It was in 1857 that he first placed before the trustees formally his idea of what the growing requirements of the British Museum needed; but long before that he had foreseen and urged the necessity of a great and radical change.

The British Museum, after ninety years of existence, had then become overcrowded in every department, notwithstanding the immense relief given to the library by the erection of the reading-room with its surrounding galleries, and it was proposed to spend a million of money in purchasing adjacent property for the better accommodation of the Natural History, and to remove some of the collections to other sites—the animal specimens to the Zoological Society, the minerals to the School of Mines, the insects and shells to the Linnæan Society, and so forth. Fortunately, however, amidst all the conflicting suggestions offered and proposals made, Professor OWEN came forward with a comprehensive scheme for preventing this fatal dispersion of the national treasures, and the erection at South Kensington of a single Museum for all branches of Natural History. Fortunately also he had the personal influence to carry his scheme through after twenty years of contention and entanglement, and to present the nation with the splendid buildings which now dignify their site on the Cromwell-road. Had it not been for his advocacy it is quite possible that the public collections would now have been scattered all over London, and the British Museum have been as overcrowded as it was in 1857. But Government, thanks in part to the support of the late Prince Consort, accepted the proposals of the distinguished Professor, and the result is a collection under one roof of such accumulations of natural history objects as no other city possesses. The models of dimensions and internal arrangements submitted by Professor OWEN were worked up into a design by Captain FOWKES, R.E.; but that officer dying before the working plans were completed, a fresh design was commenced and carried through by Mr. A. WATERHOUSE, Professor OWEN, however, being still the guiding head, and even in the decoration of the terra-cotta—of which material the Museum is built—suggesting the ornamentation which is so characteristic a feature of the building. On the western side, where the zoological collections are placed, the patterns and designs are all copied from living organisms; on the eastern, devoted to geology and palæontology, they are taken from fossils and extinct forms of life. From the archway of the entrance—itself a lesson in natural history—to the roof of the hall, decorated with botanical studies, the enormous edifice is a continuous exposition of the teachings and wonders of nature, and, taken as a whole, stands there a complete statement of creation, so far as human science has yet read its history in the palimpsests of the geology of the past, and in the open book of the nature of to-day. In a single visit it is possible to range through all the worlds of beast, bird, reptile, fish, and insect life; to pass in review the sea beds, with all their wonders of sponge and shell and coral, and all the forests and fields of the earth, with their foliage, flowers, and fruits; to survey the extinct creatures of a long-ago past, and to trace back the forms of modern organism to the remotest prototypes.

Here, among the reconstructed things of a former world, the loitering visitor, the chances are, may meet with the magician who has called those monstrous shapes into a new existence. For Professor OWEN raised these poor fossilised old giants out of their graves by a process which not so very long ago savoured of enchantment. A man brought him what looked like the bone of a cow's leg, and from it the Professor argued a gigantic bird, and, though he had to wait for about twenty years, he found himself right in the end; and there the great bird stands. Give him a back tooth and he conjured up a colossal kangaroo with a head that was three feet long. Show him a splinter of an egg-shell, and lo! the dinornis. There was no gainsaying him either. It looked, no doubt, like necromancy; and Professor OWEN would probably have gone to the stake, if he had lived in earlier days, for such obliquities as his iguanodon, such flat heresy as his archæopteryx. Nobody, however, thinks nowadays of burning the most trivial man of science for having the courage of his opinions; and, though Professor OWEN has borne much furious cudgelling from the conservatives of antiquated science, he has come out triumphant, and, standing among his dearly beloved monsters, can point to the prodigious facts around him as his answer to the sneers of more ignorant or less courageous thinkers. The patience with which he has had to wait, years upon years, for bone after bone to be found, has had its reward in the splendid corroboration of his judgment which each, as it came to him, afforded; and now that his galleries of palæontology and geology are so far completed, he has as ample grounds for contentment as the world has for gratitude. The man of science, whom it has pleased her Majesty to honour, has read off for his generation and for all that are to come some of the grandest truths of Nature, some of her most momentous secrets. He has marshalled into the orderly scheme which great minds had already grasped the wonders of a past world, and brought into harmony with the latest teachings of science the earliest of Nature's handiworks. His retirement, therefore, from the British Museum, if it really meant a positive severance of his connection with that institution, would be something more than even a national loss. As it is, the country, while congratulating Sir RICHARD OWEN upon the distinction that marks his eightieth year of life, can also to congratulate itself upon the fact that his personal counsels are still in their service. To those who have worked so long with him, "the dear old Professor" has become something more than an official-in-chief; for he has known how, by personal encouragement, by the impartial reward of praise wherever he recognised merit, to attach to himself personally the very able staff that he has organised and trained; so that they, as well as the public, would have Sir RICHARD thoroughly understand that, though he may have a successor appointed, he will himself remain Grand Lama in the temple to Nature which he has had built, as long as he lives, and that they earnestly hope it may be for many years to come.

29 November 75

Dear Mrs Woodward

The small degree in which
my name may be known, beyond
[illegible]

we just up at the Bath Stables,
with directions to call at the
house you chuse, in the evening
- after Moon-rise.
Of course, if it were a bad
raining day, my pleasure might
be postponed.
If you come early for a stroll
in Park & Garden - We dine
at 5 p.m. Sincerely yours'...

Richd. Owen

SELDOM has the honour of knighthood been conferred more worthily, or with a larger measure of public approbation, than upon Professor OWEN. The distinction, perhaps, has come somewhat tardily; but its bestowal now coincides with the moment of the retirement of the illustrious octogenarian from the active duties of his post as chief of the British Museum of Natural History, and is, therefore, felicitously opportune. Yet, after all, knighthood or no knighthood, the great Professor has his monument and perpetual memorial in that superb edifice at South Kensington, that temple to Nature, which the nation owes in great measure to his unflagging enthusiasm and his determined advocacy. A quarter of a century has elapsed since Sir RICHARD OWEN first urged upon the Government the necessity for the new Museum; and, though the scale by which he guaged his requirements and the totals in which he summed up the necessary expenditure were such as to appal the guardians of the public purse, yet science, working for the national good, had its way at last, and persistent counsels their ultimate triumph. Fortunate, therefore, beyond many who have laboured with the same single-minded energy towards a special object, the youngest of our Knights of the Bath has lived to see his ambitions completely realised, and to know that nothing now can prevent London from possessing the grandest museum for the study of natural history that the world possesses. As the founder of the British School of Comparative Anatomy, as the author of works of unique value, as the chief of palæontologists, he has laid the whole world under a common obligation and taken rank with those organising master-minds of science, LINNÆUS, CUVIER, and DARWIN. As the most courageous of the champions of public interests, and in insisting upon having the new Museum built—and built upon a scale worthy of its purpose—as the most indefatigable of superintendents, he has earned the gratitude of his own country in a degree that seldom falls to human good fortune. Not that the old professor is lost as the new knight to South Kensington. For his rooms remain there just as in the past, and the venerable figure, that all who work under him have learned to greet with an almost affectionate respect, will still be familiar in the old places to the staff and to visitors. The burden of the day may well fall now on younger shoulders, but South Kensington cannot yet spare its NESTOR, nor science afford to let him take that rest which his honourable years might claim.

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Here, among the reconstructed things of a former world, the loitering visitor, the chances are, may meet with the magician who has called those monstrous shapes into a new existence. For Professor OWEN raised these poor fossilised old giants out of their graves by a process which not so very long ago savoured of enchantment. A man brought him what looked like the bone of a cow's leg, and from it the Professor argued a gigantic bird, and, though he had to wait for about twenty years, he found himself right in the end; and there the great bird stands. Give him a back tooth and he conjured up a colossal kangaroo with a head that was three feet long. Show him a splinter of an egg-shell, and lo! the dinornis. There was no gainsaying him either. It looked, no doubt, like necromancy; and Professor OWEN would probably have gone to the stake, if he had lived in earlier days, for such obliquities as his iguanodon, such flat heresy as his archæopteryx. Nobody, however, thinks nowadays of burning the most trivial man of science for having the courage of his opinions; and, though Professor OWEN has borne much furious cudgelling from the conservatives of antiquated science, he has come out triumphant, and, standing among his dearly beloved monsters, can point to the prodigious facts around him as his answer to the sneers of more ignorant or less courageous thinkers. The patience with which he has had to wait, years upon years, for bone after bone to be found, has had its reward in the splendid corroboration of his judgment which each, as it came to him, afforded; and now that his galleries of palæontology and geology are so far completed, he has as ample grounds for contentment as the world has for gratitude. The man of science, whom it has pleased her Majesty to honour, has read off for his generation and for all that are to come some of the grandest truths of Nature, some of her most momentous secrets. He has marshalled into the orderly scheme which great minds had already grasped the wonders of a past world, and brought into harmony with the latest teachings of science the earliest of Nature's handiworks. His retirement, therefore, from the British Museum, if it really meant a positive severance of his connection with that institution, would be something more than even a national loss. As it is, the country, while congratulating Sir RICHARD OWEN upon the distinction that marks his eightieth year of life, can also to congratulate itself upon the fact that his personal counsels are still in their service. To those who have worked so long with him, "the dear old Professor" has become something more than an official-in-chief; for he has known how, by personal encouragement, by the impartial reward of praise wherever he recognised merit, to attach to himself personally the very able staff that he has organised and trained; so that they, as well as the public, would have Sir RICHARD thoroughly understand that, though he may have a successor appointed, he will himself remain Grand Lama in the temple to Nature which he has had built, as long as he lives, and that they earnestly hope it may be for many years to come.

to offer me of being so
honorably associated with Art.
I can only thank you for this
flattering evidence of your
appreciation, & am,

Yours most truly
& obliged,
Richard Owen.

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16th September 82

My dear Woodward,

Some venison has reached me from Florence Court, which will be cookable on Wednesday 20th. I know the pleasure it would give Lord E. to learn that you had partaken. If fine, come early for a stroll in the

BRITISH MUSEUM (NATURAL HISTORY),

CROMWELL ROAD,

1st October, 1883. SOUTH KENSINGTON, S.W.

Dear Dr. Woodward,

You may probably be disposed to recommend a Grant in aid of formation of the series of coloured casts referred to in the enclosed. A set of these would be an instructive addition to the Department in your Keeping —

Faithfully yours

Richd. Owen

Dr. Woodward, C. R. S.

HUNTERIAN LECTURES

ON THE

GENERATION AND DEVELOPMENT OF THE INVERTEBRATED ANIMALS.

By RICHARD OWEN, F.R.S.,

HUNTERIAN PROFESSOR AND CURATOR OF MUSEUM OF ROYAL COLLEGE OF SURGEONS, CORRESPONDING MEMBER OF THE INSTITUTE OF FRANCE, &c.

[*Reported expressly for the Medical Times, and revised by the Lecturer.*]

LECTURE IV.

GENERATION OF POLYPI.—General character and divisions of the class.—Spontaneous fission rare; gemmation the rule.—Process of Gemmation: buds detached in Hydra, retained and developed in Sertularia.—Male and female organs in Hydra.—Various conditions of the male in dioecious polypes.—Various positions of the ovaria.—Individuals from buds develope ovaries or sperm-sacs, and propagate males or oviparous females.—Alternate generation of Plumularia and Coryne.—Ova and embryos of Bryozoa.—Antiquity of the Class, and importance of Lithophytous polypes in modifying the crust of the earth.

MR. PRESIDENT AND GENTLEMEN,—The groupe of animals which is to form the subject of this Lecture is hardly less widely diffused over the globe than those we considered on the former occasion, and the individuals, also, of the groupe are so minute as to require for the most part microscopic examination, in order to unfold their anatomy; the exceptions to this are few, and are presented by the *actiniæ*, or Sea-anemonies. The name Polypi, which is now given to this class, was originally applied by the Greek naturalists to that class of higher organised invertebrata to which we now give the name of Cephalopoda, some of the species of which, still common in the Ægean Sea, were described very accurately and anatomically by Aristotle and the external resemblance of which to the little modern Polypi is singularly close, owing to the disposition and form of the feet, as a radiated circle of tentacula at the anterior part of the body. The common external characteristics of both groupes are—the development of tentacula, or prehensile organs, from the anterior extremity of the body. But beneath this outward form are concealed very different types of organic structure; in fact, the highest and lowest that are met with in the invertebrate series. The Cephalopodous polypi are amongst the most active and predacious of marine invertebrata; the *polypi* of modern zoology are rooted like plants, and commonly ramified and composite like plants; they seem to have been unknown to the ancients, and their recognition as members of the animal kingdom is of comparatively recent introduction: it cannot be dated further back than the time of Imperato in 1599, and Peyssonel in 1756. Amongst those naturalists who have subsequently contributed to improve and extend the history of the Polypes, our countryman Ellis will always take a high rank.

A polype generally presents a cylindrical or oval body, with an aperture at one of its extremities, which is surrounded by a coronet of long tentacula. In most of the class this aperture leads to a simple digestive cavity, consisting of a stomach without intestine: in the higher organised species, the digestive sac is prolonged into an intestinal canal, which is bent upon itself, and terminates by a distinct anus opening upon the external surface. The organisation of the polypes is in general very simple, and their faculties or vital phenomena seem feeble and inconspicuous. Nevertheless, the influence of their combined powers in modifying the crust of the earth, is neither slight nor of limited extent.

This great division of the radiated animals is divided into three groups or classes, according to the modifications of the alimentary canal. In the first and lowest organised class, which I have called *Hydrozoa*, digestion is performed by the secretion of a simple sac, excavated in the gelatinous and granular parenchyme of the body. In the second class, called *Anthozoa*, the digestive sac, which, like the first, throws out the rejectamenta by the same aperture as that which receives the nutriment, is suspended by a series of vertical folds of membrane in a distinct abdominal cavity, to the outer parietes of the body. In the third and highest class, called by Ehrenberg *Bryozoa*, the alimentary canal, which is likewise suspended loosely in an abdominal cavity, is provided, as has been already stated, with a distinct mouth and anus. The simplest of these groups is well represented by the little fresh-water polype of our own streamlets, in which they may be found with little difficulty in the summer season. The general external form is well shown in these relaxed specimens of the hydra viridis, and the hydra fusca. If the tissue of these be examined, it is found to present, with the exception of the prehensile arms, such an organism as you may find in the ordinary lower class of plants, the "plantæ cellulares." The external cells are condensed, and elongated in the axis of the body, so as to form two tegumentary layers; the internal cells are elongated transversely to the axis of the body, and form a stratum of villi, projecting into the abdominal cavity; the thick intermediate mass of nucleated cells seems to fulfil the ordinary functions of muscular or contractile tissue.

The hydra commonly adheres, by a small prehensile disc, or rudimentary foot, situated at the extremity of the stem or body opposite to the mouth. When the little animal would change its position it slowly bends its body, and, fixing one or more of its tentacula to the supporting surface, detaches the posterior sucker, approximates it to the head, and advances by a succession of these leech-like motions. The hydra can make progress in water, as well as on a solid plane; when it would swim it suspends itself to the surface of the water by its foot or terminal sucker, which it expands, and exposes to the air: the disc soon dries, and in this state, repelling the surrounding water, it serves as a float, from which the hydra hangs with its mouth downwards, and can row itself along by means of its tentacula. Its ordinary position is one of rest, adhering to an aquatic plant by its terminal sucker, with the dependent oral tentacula spread abroad in quest of prey.

Should a small Näis, or Entomostracan, or any of the larger Infusories, come within the reach of the little carnivorous polype, they are immediately seized, pulled towards the mouth, and swallowed. The rapidity of the digestive process is manifested by the diffusion of any characteristic colour of the animalcules swallowed, through the gelatinous parenchyma of the devourer; and when this process is completed, the indigestible *débris* of the prey are rejected by the same aperture which had just gorged it.

Each tentaculum in the *Hydra fusca* is a slender membranaceous tube, filled with a fluid albuminous substance mixed with oil-like particles. This substance swells out at certain definite places into denser nodules, which are arranged in a spiral line. Each nodule is furnished with an organ of touch, and another singularly-constructed one for catching the prey. The organ of touch consists of a fine sac, enclosing another with thicker parietes, and within this there is a small cavity. From the point where the two sacs coalesce above, there projects a long spine, which is non-retractile. The seizing organ consists of an obovate transparent sac, immersed in the nodule with a small aperture. At the bottom of the sac, and within it, there is a solid corpuscule, which gives origin to a calcareous sharp sagitta or spine, that can be pushed out at pleasure, or withdrawn until its point is brought within the sac. When the hydra wishes to seize an animal, the sagittæ are protruded, by which means the surface of the tentacula are roughened, and the prey more easily retained: Corda believes that a poison is at the same time ejected. The nodules of the tentacula are connected together by means of four muscular bands, which run up, forming lozenge-shaped spaces by their intersections; these are joined together by transverse bands. There is no communication between the tube of the tentaculum and the cavity of the body. The lip of the mouth is armed with spines, similar to those of the tentacula; but the rest of the body is destitute of them.

That the tentacula have the power of communicating some benumbing shocks to the living animals which constitute the food of the Hydra, is

Dear — We have date — the
Chief Dine at 6 p. m.

I did not forget your late
happy multi-anniversary!

With kind regard to your circle,

Sincerely yours,

Rich. Owen.

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LECTURE IV.

evident from the effect produced; for example, upon an Entomostracan, which may have been touched but not seized, by one of these organs. The little active crustacean is arrested in the midst of its rapid, darting motion, and sinks, apparently lifeless, for some distance; then slowly recovers itself, and resumes its ordinary movements. These and other active inhabitants of fresh waters, whose powers should be equivalent to rend asunder the delicate gelatinous arms of their low-organised captor, do, nevertheless, perish almost immediately after they have been seized, and so countenance the opinion of Corda of the secretion of poison; unless, indeed, the little polype may have the power of communicating an electric shock.

The most extraordinary properties of the Hydra are, however, those which best accord, and might be expected to be associated, with its low and simple cellular grade of organisation; although they excited the greatest astonishment in the physiological world when first announced by their discoverer, Trembley, and are often still called wonderful.

If a polype be transversely bisected, both halves survive; the cephalic one developing a terminal sucker, the caudal one shooting forth a crown of tentacula; each moiety thus acquiring the characters of the perfect individual. But in a healthy and well-fed *Hydra*, the same phenomena will take place if it be divided into ten pieces; provided part of the cellular body of the polype be included in the segment detached. I have not observed the reproduction to take place from a separated tentacle, unless part of the base or body be also detached with it.

The Hydræ are not less remarkable for their power of generation, than for that of regenerating mutilated parts. They have been observed to multiply by spontaneous fission, dividing themselves transversely. Roesel figures a specimen in the act of transverse fission; but there may have been some previous injury at the part. But the most ordinary process of generation is by the development of young polypi, like buds, from the external surface of the old one. This property depends on the small amount of change which the germ-mass has undergone in the development of the body.

In the freshwater polype, the progeny of the primary impregnated germ-cell retained unaltered in that body, may set up, under favourable stimuli of light, heat, and nutriment, the same actions as those to which they owed their own origin; certain of the nucleated cells do set up such actions, those, *e. g.* in the *hydra fusca*, which are aggregated near the adhering pedicle or foot; and the result of their increase by assimilation and multiplication is, to push out the contiguous integument in the form of a bud, which becomes the seat of the subsequent processes of growth and development; a clear cavity or centre of assimilation is first formed, which soon opens into the stomach of the parent; but the communication is afterwards closed, and the young *hydra* is ultimately cast off from the surface of the parent This mode of propagation is termed "gemmation." It differs from the development of the hydra *ab ovo*, inasmuch as the impregnated germ-cell, which set on foot the process, is derivative and included in the body of the adult, instead of being primary and included in a free ovum. But the germ-cell is the essential part of the ovum, and the chorion an accessory and non-essential part.

According to my observations, buds are not developed indifferently from any part of the polype. I have never seen one growing from a tentacle, nor does a wound of this part lead to the development of a young hydra, like a wound of the base of the body. I conceive that the greater amount of metamorphosis which the germ-cells and nuclei have undergone in the formation of the complex organs of the tentacula is the condition of this inferior power of generation and regeneration.

The very small size in relation to the entire body, and the superficial position of the secondary germ-cell which takes on the processes of development in the Hydra, appear to be the chief conditions influencing that modification of the generative process by which a small portion only of the Hydra is taken into the system of the new individual, instead of one-half of the body, as in the case of the Monad. So insignificant is the distinction between gemmation and spontaneous fission; the essential condition of both being, as in the development of the ovum, the presence of the pellucid nucleus of a secondary impregnated germ-cell, as the centre from which all the processes in the formation of the new individual radiate.

The Hydra propagates by ova as well as by buds. It even presents a periodical development of sexual organs of two kinds: one, at the anterior or oral extremity of the body consists of small nodules or sacs, which Ehrenberg discovered to contain moving filaments, or seminal animalcules; another series of cells, developed in the posterior part of the stem, contain ova. Sometimes one individual Hydra developes only the male cysts, or sperm-vesicles; sometimes only the females ones, or ovisacs; but the rule is generally to have both kinds.

In the formation of the ova, certain of the retained germ-cells multiply themselves, and coalesce to form a larger central cell, surrounded by others of smaller size, with nuclei, the exterior of which cells are metamorphosed into a chorion. Certain other germ-cells are converted into sperm-cells, and develope spermatozoa. The ova are extruded and fertilized by these, and they develope a hydra, retaining, however, a large proportion of unchanged cells in its composition. Accordingly, this hydra may propagate by buds, and the hydra so developed may propagate again by ova, and these two kinds of generation may alternate indefinitely.

In most of the marine hydriform polypes, the delicate tissue of the body is supported in the waves and breakers, and protected from the briny element, by an external horny integument. Were such a polype to propagate by gemmation, and the external crust to grow with the growth of the bud, and expand to protect the soft digestive sac of the new polype, an apparently compound animal would result from the number of individuals so held together. Such is the nature of a vast family of marine zoophytes which our Lyncean Ellis has so accurately described and beautifully figured as 'Corallines."

The species of the marine Hydrozoa which is nearly akin to the fresh-water hydra, is the Tubularia Indivisa, beautifully figured in this fine work on the "Remarkable Animals of Scotland," by Sir John G. Dalyell, who has devoted some twenty or thirty years to the careful examination of the animals of the Frith of Forth. In this species each individual is distinct, like the hydra; it propagates its kind by gemmation, and has, also, great powers of reparation, reproducing its polype head and double crown of tentacles many times in succession. It also propagates by ova. These are formed, in a groupe of long ovarian tubes or sacs, which proceed from the space between the long and the shorter tentacula, and, in proportion as these ovaria or ovisacs are developed, the tentacula begin to decay, and the whole flower-like head falls of with all the ovisacs. When cast off, the head does not lose its vitality, but moves, for a few days, perhaps, and crawls off with these eggs to some distance from the parent. A locomotive ciliated animalcule like a planaria, and called by Sir J. G. Dalyell "*planula*," issues from the ovum; swims by its cilia, and has the power of moving by a general contraction of its tissues. It crawls rather than swims, and in twenty four hours presents the appearance of a body with a series of peripheral rays; settles, expands, and a stem shoots up, developes a polype, and thus a new individual is generated.

These also must propagate by ova, in order that the species may be dispersed. In some species the germ-cells are metamorphosed into ova at particular parts, and the concomitant growth of the soft tissue and outer crust furnishes those ova with a capsule; which modification in the growth of the coralline Professor E. Forbes compares with that "metamorphosis in flowering plants in which the floral bud is constituted through the contraction of the axis and the whorling of the individuals borne on that axis, and by their transformation into the several parts of the flower."

The ova may escape from the ovi-capsule in the condition of ciliated locomotive bodies, called "planulæ" by Sir John Graham Dalyell; or the planulæ may be hatched in the interior of a polype-individual developed from the summit of the ovi-capsule, and which, after liberating them, may wither and fall like the flower of a plant, as in some *Campanularia*. Or a generated individual of a particular form, such as, *e. g.* the *Medusa octocilia* and *duodocilia* of Dalyell, developed from *Eudendrium ramosum*; and the *Tintinnabulum* or Bell-medusa observed by the same author to be developed from the *Campanularia dichotoma*, may be developed and become detached, and, by its own power of locomotion, carry the contained ova to a distance from the composite and fixed groupe of nutritive individuals.

The ova may be developed within the bell-shaped Acalephoid prior to its detachment, as in the *Coryne vulgaris*, observed by Wagner, or not until it has become detached and acquired the full characters of a bare-eyed Medusa (*Gymnophthalmata*, E. Forbes).

This remarkable phenomenon is best shown in the claviform Corallines, and has been especially described by Loven, in an excellent Memoir on the *Syncoryne ramosa* of Sars, and by Steenstrup in the *Coryne Fritillaria*. This species originally developes a many-armed nutritive polype, or individual; but retaining many unchanged germ-cells, these, by the stimulus of the excess of nutriment, begin to repeat the process, and push out buds in an analogous position to that in the *Hydra fusca*, viz., around the base of the stomach of the first, or parent animal; but the buds, instead of repeating the form and condition of that animal, take on a higher form, resembling that of a bell-shaped Medusa; they become detached and swim off to a distance, forming and discharging the ova, which, as Steenstrup conjectures, in their turn develope the fixed polype-shaped *Coryne*.

This stage of the cycle has not yet been the subject of observation; but, by the analogy of the larger Medusæ, is the more probable process than that direct metamorphosis of the medusiform individual into the pedunculate polypoid individual, which V. Beneden has described by the aid of a conjectural figure in the *Tubularia*. (a)

In the *Eudendrium ramosum* Sir J. G. Dalyell observed the ovicapsules, containing the young medusoid animal to be developed, from many parts of the parent stem. A very active movement of the inclosed animal may be seen near the mouth of the ovicapsule. It then opens; a small white bud protrudes, then some tentaculæ, in active struggling motion; and at last a little free-swimming medusoid animal appears, in the shape of a small bell. It courts the light, and manifests all the characteristics of the Acalephæ. Many elegant modifications are observable in the form of the ovicapsules. Sometimes they are crossed by transverse bars; sometime shaped like a vase, and provided with a little lid or cover; sometimes traversed along the middle by a continuation of the soft tissue of the polype, which may be compared to an umbilical cord. From this, in Campanularia, Mr. Lister observed the ova to be successively developed, and proceed to the mouth of the capsule, where one or more polypi make their appearance, into which the ova pass, and are developed into planulæ, when the generative or nursing polypes are cast off, and carried perhaps to some distance; after which, the locomotive planulæ is changed into a fixed zoophyte.

The medusiform ovigerous locomotive or distributive individual of the *Coryne* and *Campanularia dichotoma* is obviously homologous with the polype-shaped ovigerous individual, which seems to nurse, as it were, the ova into planulæ in the *Campanularia geniculata*; and the nutritive gemmiparous polypiform individuals in all the compound Radiaries would seem rather to manifest the typical form of the species; as the leaf is a more typical form of

(a) "Recherches sur l'embryogénie des Tubulaires," 4to., 1844. pl. 2. fig. 5.

the plant than the parts of the flower. Superadd, however, distinct nutritive and circulating organs to the free-moving ovigerous individual, and prolong its existence, and it would then cease to have the subordinate character of a nurse to the ova of the fixed individuals, and would assume that of the perfected form of the species; and such, in fact, is the case with the larger gelatinous Radiaries called Medusæ.

When the ovisac is the seat of development of a medusoid oviparous individual, as observed by Sir J. Dalyell, the phenomena attending he escape of these is remarkable. Great exertions are made to force the orifice, until the animal finds its way out; and portions of sea water in which specimens of tubularia ramosa have been kept, are sometimes found crowded with the little Medusoid animalcules. This phenomenon much surprised Sir J. Dalyell, until he became aware of the origin of them. His observations have been confirmed by Sars and others on the *Podocoryna carnea* and the *Coryna mutans*. In the same month in which Sars observed the development of Medusoid animalcules from the *Podocoryna carnea*, he found other specimens of Podocoryna developing clear capsules containing ova. Steenstrup, who was more successful in preserving the life of the Medusoid individuals, appears to have traced the phenomena of the development of the ova in them, and arrived at the conclusion that they are not directly transformed into the polyp as Van Beneden supposed; but that they developed either ova or sperm-sacs; which giving origin to "planulæ," these by the metamorphosis so well described by Sir J. Dalyell, would finally produce the rooted zoophyte, from which a compound ramified groupe might result by successive incomplete gemmations. So that with regard to the generation of the compound zoophyte we find these modifications, either the ovisacs arise from the body of the polyp, and are cast off, or bell-shaped Medusæ are developed in capsules from different parts of the body, and escape; or else, a small nursing polyp is developed, which incubates the ova, and falls like a flower. Or Medusæ may be produced by gemmation, as in Syncorynæ, and these, becoming detached, continue to move for some time (fifteen or eighteen days) before they fully develope the ova, which produce the planulæ, which are metamorphosed into the compound zoophyte.

With regard to the propagation of the *Anthozoa*, there are many points of difference. These differ from the Hydrozoa, not only in the important anatomical character of a distinct abdominal cavity, with mesogastric lamellæ, *mesorchia*, and *mesoaria*; but the ova and the matter of the sperm are developed respectively in distinct *internal* ovaria and testes.

In the anthozoic polypes of the red coral, most of the individuals are androgynous, and present both the ova and the spermatozoa; but a few instances occur in which some polypes develope only the one kind of generative product, and others the other kind. The ova of the anthozoa are detached from the internal ovaria, and impregnated, and fall into the abdominal cavity; they are hatched in that cavity, benefited by the fluids of the cavity and the seawater circulated over it by the action of the vibratile cilia, and, after attaining the form of the parent, they enter the stomach of the parent, and are ejected by the mouth. This curious mode of birth may be seen in the actiniæ of our own coast, commonly in the summer-time.

Many of the large actiniform polypes of the tropical seas combine with a structure which is essentially similar to our own sea-anemonies, an internal calcareous axis or skeleton, which, penetrating the interior of the mesogastric folds, presents the lamellated and radiated structure which we recognise in the enduring support of the large *Fungiæ* and in the polype cells of the skeletons of the *Caryophilleæ*, *Madreporæ*, &c.

The species of polypes which take the most important share in the fabrication of the coral islands and reefs, belong to the present groupe, and have essentially the organisation of the sea-anemony, which has just been described.

To the eight-armed division of the Anthozoic Polypes belong those species which have an internal ramified calcareous or jointed axis, as the red coral polype, the gorgonia, and the isis. To this division likewise belongs our common *Alcyonium*, or dead-man's-toes, in which the hard axis is wanting; and the phosphorescent Sea-pens, the *Veretillum*, and other *Pennatulidæ*, in which it is in detached pieces.

In those singular forms of compound polyps, called *Pennatulæ*, or sea-pens, the ova are found in the common stem or axis of the polyp. But groups of individuals have been found in which only sperm-sacs are developed.

In reference to the highest order, the *Bryozoa*, there we find the general plan of generation to agree with the lowest, that is, by buds or gemmation, leading to the formation of compound groups, and by ova producing locomotive ciliated gemmules. The complicated and characteristic condition of the alimentary canal in the Bryozoa was discovered independently, and nearly about the same time, by Ehrenberg, Milne Edwards, and Dr. V. Thompson. The ciliated structure of the arms was observed by Steinbuch and Dr. Fleming. The ciliated gemmules, and their development, have been well described in the *Flustra carbesia* by Dr. Grant. All these observations have received a welcome confirmation, and many highly interesting facts in the organisation and properties of the *Bryozoa*, have been added, by Dr. A. Farre; a careful perusal of whose admirable Memoir in the Philosophical Transactions for 1837, will amply repay the reader.

Most of the Bryozoa are microscopic; but, being composite or aggregated animals, they sometimes form sufficiently conspicuous masses. The most familiar and common species constitute the substance called sea-mat (*Flustra*), which incrusts, by its little hexagonal cells, as by a delicate mosaic pavement, sea-weed, shells, and other marine bodies. The calcareous sea-mat is called *Eschara*. Some species rise from their surface of attachment and form amorphous masses, like sponge; or are regularly and delicately ramified, like the little hydriform corallines.

Each polype presents an oblong depressed, or elongated and cylindrical figure, and is protected by a dense integument in the form of a cell or case, to the mouth of which is attached a sac, composed of very delicate and flexible membrane. This constitutes the upper or anterior integument of the polype when it is protruded, and is reflected, like the inverted finger of a glove, into the firmer portion of the cell when the polype is retracted. In general the integument forming the firm cell is of a horny texture; but in the *Escharæ* it is hardened by the deposition of particles of carbonate of lime in the organised animal basis.

Certain polype individuals are completely male, and develope only spermatozoa; others are exclusively female. In the Halodactylus, the ova are developed in the common uniting mass of the polyps. The ova undergo development in a cyst, and result in a gemmule or larvæ, having the cilia located on certain lobes or organs near to the orifice of the digestive sac; so that they typify the Rotifera. Their movements are, accordingly, more varied than those of the planulæ of the Hydrozoa, consisting in their making sommersaults, waddling about from side to side, or gyrating on their axis. The period during which they have been observed to move thus, is forty-eight hours; they then settle and attach themselves, having first cleared off all foreign bodies from the spot by the whirling movements of the cilia. The whole of the ciliated gemmule is not converted into the first polyp, but only a part, and this retains much of the primitive cellular and nuclear structure; so that the part not converted into a polyp is in a condition to manifest the parthenogenetic mode of propagation by gemmation.

But it is time that I should endeavour to relieve the weariness of attention to these minute details in the generative economy of these minute and seemingly insignificant animalcules, by some notice of their higher relations to the world in which their vital career is thus maintained. These relations are interesting and important, chiefly by virtue of their peculiar property to support themselves by aggregating a quantity of carbonate of lime in their interior; and the constant progress of this accumulation is such, that considerable portions of the globe become covered with it. The influence which these zoophytes exert on the surrounding ocean, moreover, is not very unlike that which the Infusoria exert in regard to the atmosphere. The zoophytes effect a chemical change on one of the mineral products carried into the sea by every river that flows through a lime-stone district. The caustic soluble lime carried incessantly into the ocean, is seized by the myriads of calcareous zoophytes, combined with one of their own excrete products, and precipitated in the form of harmless insoluble carbonate of lime.

The most important productions of the apparently insignificant race of the Polypi are the accumulations of these calcareous skeletons of the *Anthozoa*, which form the coral islands and reefs,—the dread of the navigator, the admiration of the lover of the picturesque, the subjects of the closest and most interesting speculation to the naturalist and geologist.

That masses of rock many leagues in extent should be founded in the depths of the ocean, and built up to the height of hundreds of feet by minute, frail, gelatinous animalcules, is, indeed a phenomenon calculated to stagger the unversed in zoological science, and which has demanded the repeated observation of the most accomplished and enlightened voyagers to render intelligible.

These zoophytic productions have been recently classified by Mr. Darwin under three heads:—"atolls," "barrier reefs," and "fringing reefs." The term *Atoll* is the name given to the coral-islands, or lagoon-islands, by their inhabitants in the Indian Ocean. An atoll consists of a wall or mound of coral rock rising in the ocean for a considerable depth, and returning into itself so as to form a ring, with a lagoon, or sheet of still water in the interior. The wall is generally breached in one or more places, and when the breach is deep enough to admit a ship, the atoll affords it a convenient and safe harbour. The outer side of the reef usually sinks to a depth of from two to three hundred fathoms, at an angle of forty-five degrees or more: the internal side shelves gradually towards the centre of the lagoon, forming a saucer-shaped cavity, the depth of which varies from one fathom to fifty. The summit of the exterior margin of the reef or wall is usually composed of living species of *Porites* and *Millepora*. The *Porites* form irregularly rounded masses of from four to eight feet broad, and of nearly equal thickness; other parts of the reef are composed of thick vertical plates of the *Millepora complanata* intersecting each other at various angles, and forming an exceedingly strong honey-combed mass. The dead parts of these calcareous skeletons are often cemented over with a layer of the marine calcareous vegetable called *Nullipora*, which can better bear exposure to the air.

This strong barrier is well fitted to receive the first shock of the heavy waves of the fathomless ocean without; and what at first appears surprising, instead of wearing away at its outer edge, it is here only that the solid reef increases. The coral animals thrive best in the surf occasioned by the breakers. Through this agitation an ever-changing and aerated body of sea-water washes over their surface, and their imperfect respiration is maintained at the highest state of activity. Abundant animalcules, and the like objects of food, are thus constantly brought within the sphere of the tentacula of the hungry polypes. Their reproductive gemmules are rapidly and extensively dispersed amongst the crevices of the calcareous mass.

By the force of unusual storms this outer reef is occasionally breached, and huge masses are torn off and driven towards the lagoon, where they form an inner barrier or reef. The broken surface becomes the seat of attachment of the young of the neighbouring corals, the successive generations of which, by the rapid growth and development of their calcareous skeleton, soon repair the damage of the storm. The masses of broken coral thus driven inward towards the lagoon, accumulate

in time to the height of some feet above high water. These fragments are mixed with sand, and shells, and form a favourable soil for the development and growth of vegetables, as cocoa palms, the large nuts of which may be borne hither by currents of the ocean, from Sumatra or Java, 600 miles distant. Turtles likewise float to the nascent island, browse on the sea weeds which grow in the lagoon, and breed there. Numerous species of fish and shell fish flourish in the same still water, which abounds with animal life. Man comes at length and takes possession of the island; and the cocoanut, the turtle, and the fish afford him abundant and wholesome food. But you will ask how he supplies himself with that necessary of life, fresh water? This is obtained in a very simple and unexpected manner from shallow wells, dug in the calcareous sand, which ebb and flow with the tides, yet are almost wholly free from the saline particles of the ocean. Some have supposed that the sea water lost its peculiar salts by infiltration through the calcareous mass. Mr. Darwin thinks that it is derived from the rain water, which, being specifically lighter than the salt, keeps floating on its surface, and is subject to the same movements; howsoever this may be, the fact is certain. A fit and convenient abode for the human species is fabricated by the action of the feeble, gelatinous polypes, and a wild and almost boundless waste of waters is enlivened by oäses, which navigators have described as earthly paradises.

A Barrier Reef is essentially similar to the Atoll or Coral Island. It runs parallel with the shores of some larger island or continent, separated, however, from the land by a broad and deep lagoon channel, and having the outer side as deep and steep as in the Lagoon Islands. Here, likewise, the skeletons of the zoophytes, of which the reef is composed, are found on the outer precipitous wall, as deep as sounding-line can reach.

The third class of coral productions which Mr. Darwin terms "Fringing Reefs," differ from the Barrier Reefs in having a comparatively small depth of water on the outer side, and a narrower and shallower lagoon channel between them and the main land.

These differences in the characters of the wonderful fabrications of the coral animalcules are explicable by the following facts in their physiology. The animals of the *Porites* and *Millepora* cannot exist at a greater depth than twenty or thirty fathoms; beyond this the stimuli of light and heat derived from the solar beams become too feeble to excite and maintain their vital powers. On the other hand, their tissues are so delicate, that a brief direct exposure to the sun's rays kills them; and unless they are constantly immersed in water or beaten by the surf, they cannot live. Thus, in whatever position the calcareous skeleton of a Madrepore or Millepore may be found, it is certain that it must have been developed within thirty fathoms of the surface of the ocean. If it coats the summit of the lofty mountains of Tahiti it must have been lifted above the sea by the elevation of the rock on which it was originally deposited. Mr. B. Stutchbury here found a regular stratum of semifossil coral at 5,000 and 7,000 feet above the level of the sea. If it is brought up from the depth of 200 or 300 fathoms, as at Cardoo Atoll or Keeling Atoll, it must have been dragged down to that depth by a gradual subsidence of the foundation on which the living madrepore once flourished. It is by these movements of upheaval and subsidence of the earth's crust, that Mr. Darwin explains the different forms which characterise the extraordinary productions of the coral animal. The *Atolls*, or Lagoon Islands, according to this author, rest on land which has subsided, and part of which was once dry. *Barrier reefs* indicate the islands or continents, which they encircle, to be the remains of land now partly submerged, and perhaps in progress towards final disappearance. *Fringing reefs*, on the contrary, indicate either that the shores are stationary, or that they are now rising, as in most of the Sandwich Islands, where former reefs have been raised many yards above the sea.

Elizabeth Island, which is eighty feet in height, is entirely composed of coral-rock. The coral animals, thus progressively lifted above their element, are compelled to carry on their operations more and more remote from the former theatres of their constructive energies, but cannot extend deeper than their allotted thirty fathoms: the direction of their submarine masonry is centrifugal and descending. Where the land that supports them is, on the contrary, in progress of submergence, they are compelled to build their edifices progressively higher and in a narrower circuit; in other words, the direction of their growth is centripetal and ascending. The terms ascending and descending, of course, only here apply to the relation of the coral-builders to the unstable land, not to the level of the unchanging sea.

The prodigious extent of the combined and unintermitting labours of these little world-architects must be witnessed in order to be adequately conceived or realised. They have built up a barrier-reef along the shores of New Caledonia for a length of 400 miles, and another which runs along the north-east coast of Australia 1,000 miles in length. To take a small example, a single atoll may be 50 miles in length by 20 in breadth; so that if the ledge of coral rock forming the ring were extended in one line it would be 120 miles in length. Assuming it to be a quarter of a mile in breadth, and 150 feet deep, here is a mound, compared with which the walls of Babylon, the great wall of China, or the pyramids of Egypt, are but children's toys; and built too amidst the waves of the ocean and in defiance of its storms, which sweep away the most solid works of man. The geologist, in contemplating these stupendous operations, appreciates the conditions and powers by which were deposited in ancient times, and under other atmospheric influences than now characterize our climate, those downs of chalk which give fertility to the south coast and many other parts of our native island. The remains of the corals in these masses, though similar in their general nature, are specifically distinct from the living Polypes which are now actively engaged in forming similar fertile deposits on the undulating and half submerged crust of the earth, washed by the Indian and Pacific Oceans. Again, those masses of limestone rocks which form a large part of the older secondary formations, give evidence, by their organic remains, that they are likewise due to the secretions of gelatinous polypes, the species of which perished before those that formed the cretaceous strata were created. As the polypes of the secondary epochs have been superseded by the *Porites*, *Milleporæ*, *Madreporæ*, and other genera of calcareous Anthozoa of the present day, so these, in all probability, are destined to give way in their turn to new forms of essentially analogous Zoophytes, to which, in time to come, the same same great office will be assigned, to clothe with fertile limestone future rising continents.

Tyler and Reed, Bolt court, London.

4th January 1884.

My dear Woodward,

I write, what I would have expected on Dec. 31st., sincere good wishes for every happiness to you & your's throughout the year.

With thanks for your kind intimation, I have noted the 21st as an engagement at the Holborn Restaurant, for 5 p. m.

A.

29th May, 1884

Dear Woodward,

A proof of the Cut of skull of Rhynchosaur is all now wanting to complete the book (4 vols. 8vo), of Brit. Foss. Reptiles.

Its reception will add to my obligations.

Sincerely yours,

Richd. Owen.

30th July, 1884.

Dear Woodward,

I fear I may not be able to clear out more of the contents of the basement room before it has to be in the

Sheen Lodge
Richmond Park.

9th March 1888.

Dear Woodward,

The accompanying sketches of characters of portions of the shell of an ammonite, from the Holderness Coast, have been posted to me, for a name.

"The shell was picked up by the Captain of a life-boat, near high-water mark, supposed to have been drifted from its chalk-bed during a high tide."

If you recognize the species from the drawings these need not be returned, but the name will be gratefully received, by,

Yours most truly,

Richard Owen.

in time to the height of some feet above high water. These fragments are mixed with sand, and shells, and form a favourable soil for the development and growth of vegetables, as cocoa palms, the large nuts of which may be borne hither by currents of the ocean, from Sumatra or Java, 600 miles distant. Turtles likewise float to the nascent island, browse on the sea weeds which grow in the lagoon, and breed there. Numerous species of fish and shell fish flourish in the same still water, which abounds with animal life. Man comes at length and takes possession of the island; and the cocoa-nut, the turtle, and the fish afford him abundant and wholesome food. But you will ask how he supplies himself with that necessary of life, fresh water? This is obtained in a very simple and unexpected manner from shallow wells, dug in the calcareous sand, which ebb and flow with the tides, yet are almost wholly free from the saline particles of the ocean. Some have supposed that the sea water lost its peculiar salts by infiltration through the calcareous mass. Mr. Darwin thinks that it is derived from the rain water, which, being specifically lighter than the salt, keeps floating on its surface, and is subject to the same movements; howsoever this may be, the fact is certain. A fit and convenient abode for the human species is fabricated by the action of the feeble, gelatinous polypes, and a wild and almost boundless waste of waters is enlivened by oäses, which navigators have described as earthly paradises.

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Dear Woodward,

I fear I may not be able to clear out more of the contents of the basement room before it has to be in the work mens' hands, so what is left may be taken to the locality you have kindly granted. I hope to be with you on Friday morng.

Yours ever, R. Owen.

in time to the height of some feet above high water. These fragments are mixed with sand, and shells, and form a favourable soil for the development and growth of vegetables, as cocoa palms, the large nuts of which may be borne hither by currents of the ocean, from Sumatra or Java, 600 miles distant. Turtles likewise float to the nascent island, browse on the sea weeds which grow in the lagoon, and breed there. Numerous species of fish and shell fish flourish in the same still water, which abounds with animal life. Man comes at length and takes possession of the island; and the cocoa-nut, the turtle, and the fish afford him abundant and wholesome food. But you will ask how he supplies himself with that necessary of life, fresh water? This is obtained in a very simple and unexpected manner from shallow wells, dug in the calcareous sand, which ebb and flow with the tides, yet are almost wholly free from the saline particles of the ocean. Some have supposed that the sea water lost its peculiar salts by infiltration through the calcareous mass. Mr. Darwin thinks that it is derived from the rain water, which, being specifically lighter than the salt, keeps floating on its surface, and is subject to the same movements; howsoever this may be, the fact is certain. A fit and convenient abode for the human species is fabricated by the action of the feeble, gelatinous polypes, and a wild and almost boundless waste of waters is enlivened by oäses, which navigators have described as earthly paradises.

A Barrier Reef is essentially similar to the Atoll or Coral Island. It runs parallel with the shores of some larger island or continent, separated, however, from the land by a broad and deep lagoon channel, and having the outer side as deep and steep as in the Lagoon Islands. Here, likewise, the skeletons of the zoophytes, of which the reef is composed, are found on the outer precipitous wall, as deep as sounding-line can reach.

The third class of coral productions which Mr. Darwin terms "Fringing Reefs," differ from the Barrier Reefs in having a comparatively small depth of water on the outer side, and a narrower and shallower lagoon channel between them and the main land.

These differences in the characters of the wonderful fabrications of the coral animalcules are explicable by the following facts in their physiology. The animals of the *Porites* and *Millepor* at a greater depth than twenty or th beyond this the stimuli of light and from the solar beams become too fe and maintain their vital powers. hand, their tissues are so delicate, tha exposure to the sun's rays kills ther they are constantly immersed in w by the surf, they cannot live. Thu position the calcareous skeleton of a Millepore may be found, it is certa have been developed within thirty surface of the ocean. If it coats the lofty mountains of Tahiti it must h above the sea by the elevation of the it was originally deposited. Mr. here found a regular stratum of sem 5,000 and 7,000 feet above the level it is brought up from the depth fathoms, as at Cardoo Atoll or K must have been dragged down to t gradual subsidence of the foundation living madrepore once flourished. movements of upheaval and subsidenc crust, that Mr. Darwin explains the which characterise the extraordina of the coral animal. The *Atol* Islands, according to this author, res has subsided, and part of which *Barrier reefs* indicate the islands which they encircle, to be the rema partly submerged, and perhaps in p final disappearance. *Fringing reef* trary, indicate either that the shores or that they are now rising, as i Sandwich Islands, where former r raised many yards above the sea.

Elizabeth Island, which is eighty entirely composed of coral-rock. Th thus progressively lifted above the compelled to carry on their opera more remote from the former theat structive energies, but cannot exte their allotted thirty fathoms: the d submarine masonry is centrifugal Where the land that supports them trary, in progress of submergence, they are com- pelled to build their edifices progressively higher and in a narrower circuit; in other words, the di- same great office will be assigned, to clothe fertile limestone future rising continents.

I propose to be at the Museum tomorrow — 5th — I will not write more, than that

I am,

always most truly yours

Richd. Owen.

Tyler and Reed, Bolt court, London.

Sheen Lodge, Richmond Park.

30th July. 1884.

Dear Woodward,

I fear I may not be able to clear out more of the contents of the basement room before it has to be in the

Sheen Lodge
Richmond Park.

9th March 1888.

Dear Woodward,

The accompanying sketches of characters of portions of the shell of an ammonite, from the Kelloway's coast, have been posted to me, for a name.

"The shell was picked up by the Captain of a life-boat, near high-water mark, supposed to have been drifted from it's chalk-bed during a high tide."

If you recognize the species from the drawings these need not be returned, but the name will be gratefully received, by,

Yours most truly,

Richard Owen.

Sheen Lodge, Mortlake, Richmond Park.

29th May, 1884

Dear Woodward,

A proof of the Cut of skull of Rhynchosaur is all now wanting to complete the book (4 vols. 4to), of Brit. Foss. Reptiles.

It's reception will add to my obligations.

Sincerely yours,

Richd. Owen.

24th. March, 1885

Dear Woodward,

Oblige me by posting to "Jno.H. Warner, Esq.: Cirencester" your excellent 'Guide to the Geology'. I will defray cost & postage when we next meet. But I shall have to wait for more genial weather before I can venture out. Kind remembrances to all your Chelsea circle.

Sincerely yours,

Richd. Owen.

27th March, 1884.

My dear Woodward,

At p. 188, of my 'Palæontology' (8vo, 1860) is a Cut, (fig. 67) of a tooth of a Labyrinthodon. Could you get me that Cut copied, and let me have the block, to append to some Letter-Press I have to send to a Printer.

Pray oblige,

Yours most truly,

Richd. Owen.

28 March, 1884

Dear Woodward,

I will ask you, also, to engage an Artist to copy the Cut, No. 68, opposite p. 163 of the 'Palæontology' and shall be glad to have the Blocks of this & the Labyrinthodont both, to accompany concluding Prelp. pages of my big book on "British Fossil Reptiles" - Sincerely yours,

Richd. Owen.

Sheen Lodge - 22d May, 1884.

Dear Woodward,

As the three Proofs state the same facts, one only need appear, & the choice may be safely left to your long experience as Editor of the Geol. Mag.: I hope to look in upon you on Friday morning -

Sincerely yours,

Richd. Owen.

East Sheen - Surrey
11th April, 1884.

Dear Woodward,

Thanks for your note & request & your kind suggestion. The Printer's address is: - "Mr. Adlard, 22½ Bartholomew Close, E.C." The MS. is in hand, with the spaces marked for the two Cuts. They have come in good time -

Sincerely yours,

Richd. Owen.

13th May, 1884

Dear Woodward,

Thanks for your Note; Miss W. cannot feel greater regret at the interruption of our Work than I do - I inclose the subject for a Wood block of which I spoke when last with you -

Sincerely yours,

Richd. Owen

4th July, 1884.

Dear Woodward,

I purpose putting in an appearance at 11 a.m. on Monday 7th, when I will ask for the wood-block, and defray, with pleasure, my small debt to Miss Gertrude, many thanks will still be due to her, from,

Yours ever truly,

Richd. Owen.

9th July 1884.

Dear Woodward,

Is the "Journal of the Geological Society of Germany" in the Departmental Library. If so, 'Vol. VIII, 1856,' has, in 'Plate XV,' a figure giving the dentition of a 'Pseudo-Sciurus,' which, I am told, has molars with the grinding surface like that of Witylodon.

Should this be so I should be

22nd January, 1885.

Dear Woodward,

Thanks for your prompt announcement of the reception of M. Fitzgerald's fossils. Bronchitis may restrain my impatience till Barlow has done his good work upon them. I feel indebted to him for his devotion to Scelidosaurus.

Sincerely yours,

Richd. Owen.

HUNTERIAN LECTURES

ON THE

GENERATION AND DEVELOPMENT OF THE INVERTEBRATED ANIMALS.

By RICHARD OWEN, F.R.S.,

HUNTERIAN PROFESSOR AND CURATOR OF MUSEUM OF ROYAL COLLEGE OF SURGEONS, CORRESPONDING MEMBER OF THE INSTITUTE OF FRANCE, &c.

[*Reported expressly for the Medical Times, and revised by the Lecturer.*]

LECTURE X.

GENERATION OF ANELLATA.—Characters of the Class and of its primary divisions.—Spontaneous fission of Nais and of young Nereids.—Androgynous generative system of the Leech and Earth-worm. Dioecious arrangement of the numerous but simple testes and ovaria in Tube-worms and Nereids.—Ova, cocoons, and ametabolian development of the Leech and Earth-worm.—Development and metamorphoses of Nereids and Tube-worms.

MR. PRESIDENT AND GENTLEMEN,—From the low organised intestinal worms we pass now to the consideration of the generative economy of worms of a higher organisation, of those commonly called leeches, earth-worms, sand-worms, and tube-worms, nereids or sea-centipedes, aphroditæ or sea-mice, &c., constituting a very extensive, widely distributed, and varied class; but all vermiform, and all with the body partially divided into segments like little rings, whence the name *Annulata* or Annelides, which has been given to the class, and is now generally received; they are the "Red blooded worms" of Cuvier. The Entozoa, subsisting on the chyle or other living juices of higher animals, had a nutritive system which sometimes resembled in form and structure a ramified vascular system, but usually combined the digestive, chylific, and sanguiferous functions, and always contained a whitish, colourless fluid. In the Annulata we always find a distinct system of arteries and veins, aided by a propulsatory organ or organs. The Entozoa, being in contact with the vascular tissues of the higher animals which they infest, have no need of special respiratory organs; but in the Annellata these organs are always present, though in various grades of development, and diversely modified in structure: though always composed of vascular portions of the integument. In the leech and earth-worm, the vascular processes of the delicate integument are folded inwards, and constitute small respiratory sacs like rudimental lungs, opening by lateral spiracula: in the majority of the class, the processes of the integument are pulled outwards, and commonly ramified or tufted; sometimes radiating from the head, sometimes from the dorso lateral parts of the body-segments, and commonly of a bright red or coral colour. With this state of the circulating and respiratory system, the locomotive powers of the annulated worms are proportionally developed. In most members of the class, special locomotive organs project from the sides of the segments, in the form of short tubular processes of the integument, forming sheaths for a bundle of protractile and retractile bristles. The nervous system keeps pace with the development of the muscular system, whose actions it directs; and we now find a regular and symmetrical series of aggregated nodules of nervous matter or ganglions; and with this grade of the nervous system we find a supra-œsophageal ganglion or brain receiving sensations from rudimental eye-specks, and also from exploring processes of the integument of the head, analogous to the antennæ of insects. And here is an instructive exemplification of the law of vegetative repetition, in this first introduction of antennæ into the animal kingdom: they are not only present in two or more pairs on the head, but in some annelides are developed from the segments of the trunk, and, though similar in structure to the cephalic ones, are not called "antennæ," only because they are not situated on the head. In insects where the antennæ are fully perfected, they are reduced in number to two.

The Annellata are divided into four groups, according to easily recognised characters:—

The *Suctoria*, or Leeches, in which the locomotive organs are in the form of prehensile discs, or suckers.

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Spontaneous fission has now been observed to take place in almost every order of Annellata; and, in all, it takes place at nearly the same part, near the beginning of the posterior third part of the body; but, the formation of the new annellide is due to a process of gemmation of new segments, which proceeds from the last or penultimate joint. It is most common, or has been oftenest witnessed, in the little abranchial fresh water Naids. But, Otho Frederic Müller has represented a young Syllis (his *Nereis prolifera*) in the act, in his great work, the "Zoologia Danica." Gruithuisen has described the process in a *Chætogaster*, Oersted in an *Eolosoma*, M. Edwards in a *Myrianes* (Nereis), and Schmidt in a tubicolar Annelide, called *Filograna Schleideni*.

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The place where the process of forming the new segments is to be carried on is soon indicated by a slight swelling and increased vascular action. If the head or anterior segment of the species be

characterized by eye-specks, antennæ, a proboscis, or branchiæ, these are developed in a certain and always recognizable degree, before the final separation takes places. In the *Myrianes*, the coloured eyes indicate the young fry. In the cephalo-branchiate annellide the gills are shown, in the stage of fission represented by Professor Schmidt, as four pairs of articulated filamentary vascular processes. In the *Nais proboscidia* the characteristic proboscis shoots out from the nascent head of the young worm, which is thus duly armed before it is cast off to provide its own nutriment. The last joint of the young Naid is specially ciliated, like that of the mother; and the corresponding portion of the alimentary canal, has thick walls with numerous filamentary or vascular appendages. This gemmiparous segment resumes its procreative function in the parent as soon as the lineaments of the head of the first young Nais are established; and a second young Nais, with a rudimental proboscis, intervenes between the first and the original parent: sometimes even a third Nais is indicated by the elongation, swelling, and active vascularity of the last joint; and thus four generations of Naids may be seen organically connected, and constituting one compound individual. The compound individual is due to the succession of incomplete gemmations: the reproductive process is completed, and the compound is resolved into the single individuals, by spontaneous fission. The pedicellated cells that are aggregated in the penultimate or proligerous segment form a significant feature in its organization. As long as the Annelides propagate by this primitive mode, they manifest no ovaria or testes. These are developed in those individuals which are propagated by gemmation and spontaneous fission, when the proper season for oviparous generation has arrived. M. Edwards observed, that a Nereis allied to *Merianes* generated in succession six young from the same posterior segment, each of which developed the true generative organs, without the parent itself showing any trace of them. M. Quatrefages has noticed the same fact in a species of *Syllis*.

In many of the Annellides, therefore, the phenomena of Parthenogenesis are manifested in the immature state; and, since the individuals so propagated alone acquire the generative organs, an alternation of generations may here be affirmed of such species: the oviparous individuals producing eggs from which the gemmiparous individuals come, and these, in their turn, reproducing the oviparous individuals.

We next proceed to point out the chief modifications of the generative organs properly so called. And first, as to the generative organs of the leech. In the medicinal species (*Hirudo* or *Sanguisuga medicinalis*) may be seen a number of pairs of little grey rounded bodies, usually nine pairs, which are the testes. A little duct proceeds from each to a common longitudinal "vas deferens," which communicates near the anterior fourth of the leech with a small pyriform prostatic gland, from which is prolonged a filiform intromittent organ, which projects from the ventral surface of the twenty-fourth ring. But the leech is androgynous, and the female organs are situated behind this prostate and penis, between the seventh and eighth abdominal ganglia: they consist of two subspherical ovaria, two short oviducts, which unite to form a single oviduct that expands into a pyriform muscular uterus. The vagina opens upon the twenty-ninth segment. In the Naids the orifices of the male and female organs are in two pairs, situated about the anterior third of the body. In the *Nais proboscidia* the ovarium is included by the substance of the testis. Two cæca extend inwards, at the breeding season, from the two anterior generative pores, which are then found filled with spermatozoa grouped into fasciculi, and probably received from another individual *in coitu*. The ova are carried out by long convoluted oviducts.

In the earth-worm the external characters of the generative organs may be clearly seen in Hunter's dissections. We perceive, here, that the generative apparatus is more concentrated in the earth worm than in the leech, and more individualised than in any other animal of the Annellidous class. The three pairs of small opaque organs, which Hunter regarded as testes, may possibly be only "spermathecæ," like the anterior pair in the Naids. They are laden with spermatozoa during the breeding-time. The germinal vesicles and developing ova are found in the larger greyer-coloured cœca; each of which sends out a distinct short oviduct, and these combine into a common oviduct on each side, opening behind the orifices leading from the testes or spermathecæ. If a section of one of these ovarian sacs is made, it is found filled with a spongy matter in the centre, and the ova are situated in this. The common oviduct from each lateral series of ovaria terminates in the fissure upon the sixteenth segment, about one-third from the head. It is interesting to note here, that the condition and function of the oviduct in the earth-worm is analogous to the arrangement of the generative parts in plants. In plants the part answering to the oviduct is a distinct canal, communicating with the pistil, and serving to convey the pollen to the ova; but the ova afterwards escape by rupture of the ovarium, or by what the botanist calls dehiscence of the seed capsule. It is exactly so with the earth-worm; the so called oviducts serve to convey the impregnating principle to the ova, which escape into the abdominal cavity of the earthworm, by bursting through the ovarian sacs. In these sacs, however, there is always found a quantity of spermatozoa in different stages of development; and accordingly the generative organs of the earth-worm are open to two interpretations. The anterior organs may be regarded, as by Hunter and Cuvier, as the testes, or they may answer only to the spermatheca in insects; and, in that case, the true male organ may be that external, spongy part which surrounds the proper ovarium; and this would not be a solitary instance of such an arrangement of the esssential organs of generation in the animal kingdom, but one which is very common in the androgynous Gasteropods. However, there is much room for research and experiment to clear up this difficult moot-point.

Both the leech and the earth-worm do enjoy a double or reciprocal coitus; the leech has a true perforated intromittent organ; the earth-worm has not. During the breeding season, however, two imperforate appendages are developed from about the thirty second ring; their base adheres intimately to the cellular tissue; they have no communication with the genital apertures; are developed only at the breeding season; and are deciduous. The second accessory organ is that thickened part of an earth-worm which is situated between the thirtieth and the fortieth segments; it is called the "clitellum," and, when two earth-worms are disturbed *in coitu*, the adhering clitella are the last parts to give way.

With regard to the dorsibranchiate and tubicular Annellides, many of these are dicœcious. The sperm-sacs or testes are situated on the ventral aspect, between the layers of the ventral muscles. The development of the ova is more clear and obvious; because they are commonly remarkable for the bright colour of their vitelline mass; and the number of ova is so great, that the ordinary colour of the Annellide is changed at the breeding season. Thus, in the *Aphrodite cirrata*, Sars found that, in February, the three posterior fourths of the body were of a brilliant red colour on account of the great number of ova there accumulated. Neither testes nor ovaria have external ducts; the products of both are discharged by dehiscence into the abdominal cavity, and are excluded by pores situated near the base of the setigerous feet. In the Aphrodite, the ova pass beneath the dorsal scales, and there development takes place. There is but one known species of Annellide that exhibits external sexual characters, viz., the *Exogone* or *Cystonereis*. In the females, the middle segments exhibit pyriform sacs, attached to their ventral surface, which receive the ova after they are impregnated: the male is without these, and is smaller. The genus *Eunice* is viviparous, and the young escape from the ruptured skin of the hinder segments.

A few words now on the developement of the generative products. As to the spermatozoa, these are developed from a great number of cells connected together by a special mass, and studding its surface. Each cell is the seat of development of a separate spermatozoon; this in its growth pushes the cell wall outward, and the filamentary extremities diverge from the common spherical basis of the sperm-cells. Then, by mutual attraction, the tails become amassed together, but finally become liberated, and exhibit the individual spermatozoa.

I shall now bring before you a series of observations, made by Dr. A. Farre, on the generation and other phenomena of the spermatozoa of the common earth worm. He has very carefully traced these appearances, and has accurately figured them by the camera lucid, from which figures the diagrams have been prepared. I will read to you the letter which accompanied the drawings:—

"I think, in reference to the drawings of *Lumbricus*, that it would be more consistent with the objects that I had in view in making them, to limit my explanations in some particulars, for the following reasons. With regard to the accuracy of the figures I have no doubt. Each was drawn from the object under the microscope, with the camera lucida, so as to insure both form and relative size. Those which I left with you are selected from more than 300 figures, most of which were confirmed by several observations. The only difficulty is, in disentangling these from the mystery which is thrown over the whole process, in consequence of all the elements and stages of reproduction being found together at one and the same part of the body, for, on opening the ovary, everything, from the single spermatozoon to the almost perfect worm, may be found contained within it; and the number of observations which I have made has not yet sufficed to put the links together in an unbroken chain. To do this was my object in delaying the publication of my observations. I should at present like, therefore, to go no further than this.

"1st. The plate No. 1 represents what is observed in placing the contents of the testis between two slips of glass. In about ten minutes the whole mass is seen to heave and writhe with astonishing energy, the form of the movement being that of the peristaltic action of the intestines. Everything in contact with the spermatozoa becomes ciliated by them, one end of the filaments fixing itself whilst the other vibrates free. The result is, that if the body to which the spermatozoa attach themselves is fixed, such as the glass, on the margin of a mass of granules, a line of cilia is formed, whose action creates a strong current, and everything moveable is drawn into the vortex, and is seen drifting rapidly along. But, if the body to which they attach themselves is moveable, such as the globular bodies found in the testis itself, or those which occur in every part of the ovary, and which, being extracted from the latter, are placed, for the sake of experiment, amongst the spermatozoa from the testis, then the globular bodies soon become clothed with spermatozoa, whose free ends, moving rapidly, cause the whole body to rotate. A most remarkable object is thus formed, which continues for a considerable time in motion, clearing for itself a free area, and in this it revolves, whilst its revolutions are apparently assisted by the action of other spermatozoa, which, having attached themselves to the periphery of the cleared space, keep up a complete vortex, in which the centre body is partly a passive and partly an active agent. This remarkable property of spermatozoa, in performing the office of cilia, is, as far as I am aware, a new fact, and one which may serve to explain possibly the transference of the sperm fluid, or even of ova, of various animals, along surfaces or tubes not naturally ciliated. The drawing, No. 1, represents the scene which I have endeavoured to describe, but of the energy and vitality of which no mere description can convey any accurate idea. The observations were made in the month of June.

"With regard to the second drawing, showing the curled spermatozoa, I must beg you to use it only as illustrating what is already known of their development, of which it will supply you with a better

serial example than has yet, I believe, been put upon paper. My reason for this is, that I would prefer waiting for these facts, to prove my conjecture right or wrong, before I hazard anything on the subject. In that case, to agree with the present notions on the subject, you have only to turn my drawing upside down, which will make figure 7 the first, and figure 1 the last of the series. Then figure 7 will show the exogenous arrangement of the (supposed) sperm-cells, as proved by pressure or drying; figure 6, the ordinary appearance; figure 5, the supposed expansion of the spermatozoa beginning; figures 4 and 3, further degrees of the same; figure 2, that which other observers consider the usual final arrangement; and figure 1, that which I saw most frequently in regard to the position of the spermatozoa on the spherical bodies usually considered to be the parent developmental sperm-cells,—the latter figure also serving to show the appearance produced by artificially applying the spermatozoa to the spherical bodies found in the ovary.

"The conjecture which I offered, as to the *order* of the changes here depicted, seems to get over the difficulty of an *exogenous* production of sperm-cells, and agrees with what may be observed *to a certain point* in artificially mixing the contents of the sperm sacs with those of the ovisacs. I have no doubt of the *series* of the observations,—the only question is, as to the *right end*."

(Diagrams of the drawings were referred to.)

In regard to the development of the ova and embryo in the earth-worm; the ova, when they are impregnated, are discharged from the ovarium and fall into the abdominal cavity, being ultimately pressed on to a receptacle near the anal end of the worm. Dr. A. Farre has traced the development in several cases; and the stages in the development of the earth-worm are very analogous to those of intestinal worms. It appears that some earth worms are developed before they are excluded, but this is not always the case. The whole of the process, however, is perplexed by a considerable number of parasites, gregarinæ, pseudo-navicella capsules, and others, so that it is one of the most perplexing fields for microscopic observation.

In regard to the leech, the generative phenomena is much less dubious. Mr. Quekett and others have found the spermatozoa developed in the same manner as in the ordinary Annellides, and probably the earth-worm. The ova of the leech are spherical, and exhibit, when found in the oviducts, the usual constituents of ova. There is a germ-yolk with a germinal vesicle and spot, a delicate vitelline membrane, and a chorion. When the ova are received into the uterus the germinal spot has disappeared, intimating that impregnation has taken place; then there is a slight contraction of the vitellus, and a central germ-cell appears, which clothes itself with the yolk. When the yolk has been progressively divided into many large lobes, a large clear cell appears in the centre, before the further subdivision of the yolk takes place, which cell lays the basis of the alimentary canal. The peripheral cells begin to form the dorsal and ventral surface of the integument. A particular spot of the superficies of the spheroidal embryo, which surface becomes covered by ciliated epithelium, is developed into a sucker which communicates with the stomach, and so the embryo nourishes itself with the surrounding albumen. The body progressively elongates, loses its superficial cilia, before it is excluded, and, by the development of the posterior sucker, becomes a little leech without further metamorphosis. It is interesting to observe, that the embryo is first ciliated, and with a mouth only, like a *Planaria*, before it takes on the complete form and characters of the leech.

The leech is oviparous; the fertile ova are discharged in groups of from six to fourteen, enveloped in a nidus or cocoon of mucus. The cocoon is ovate, two thirds of an inch in length, and half an inch in diameter. It has a rough outer surface, but is smooth and slightly tuberculate within. In the month of August, conical excavations may be observed in the slime at the sides of the reservoir, in each of which there is a cocoon. In a few days after the ova have been thus expelled and protected, the young leeches are extruded. The formation of the cocoon is the result of a rather curious manœuvre in the leech. In the *Hirudo Vulgaris*, when the cocoon is about to be formed, the body is observed to be greatly contracted, both above and below the uterus; the included part swells, then becomes milky white, from the formation of a film, into which the animal, having attached itself by its anal sucker, forces, after some effort, the whole contents of the uterus. This being done, the leech elongates the anterior part of its body, and, thus loosening the enveloping membrane, withdraws its head as from a collar. It sometimes bends back its head, and, drawing the collar forwards, gently aids in its removal. The process usually occupies about twenty minutes. The cocoon is at first very elastic, and has no determinate figure. After the leech has attached it to some adjoining substance, it fashions it with its mouth into an oval form. The points of the cocoon from which the leech withdrew its head are weaker than the rest, and from these the young escape.

In most branchiated annelides, the embryo is excluded as a ciliated spheroidal animalcule. It lengthens, partially casts its cilia, retaining them arranged in cinctures or bands about both extremities. At the anterior end the eyes or eye-specks appear; the segments are indicated on the rest of the body; and the tubular feet and their bristles sprout forth; the annellide afterwards taking on the modifications which distinguish its family, its genus, and, finally, its species.

Thus, in the development of the sea-worms or Nereids, there is something which merits the name of a metamorphosis. Professor Lovén, in August, was surprised at capturing a little creature of the form above defined, girt by a double row of vibratile cilia. No indications of segments had at that time appeared. He thought, at first, that it might be some species of polygastric infusoria; but he found afterwards that the animal had a complete alimentary canal. He kept it long enough to observe other changes, such as the development of a head, with eye-specs, and then the formation of segments, each in four distinct masses; and the succession of these segments, rapidly developed, soon indicated an embryo of the annellate class, and one of the dorsibranchiate order, by the projection of tubercular setigerous feet.

As to the Aphrodite, in February, Sars found a small species, which produced richly-coloured ova, and he traced the successive development of these. He found that the ova escaped from small pores, and were received into a kind of pouch beneath the dorsal scales, and there underwent their development, and escaped. He observed the geometrical division of the rose-coloured yelk, and the clear spot in the centre of each successive division. The embryo is an active locomotive oval mass, with a little groupe of cilia, and an indication of an eye-speck to guide its course; after swimming freely for twenty-four hours the development of segments commenced. In the *Cystonereis*, in which the ova are incubated in marsupial sacs, the development of the animal appears to take place without that amount of metamorphosis which has been observed in other *Errantia*. First, there are two short tentacula, then three; then the animal elongates, and before it quits the marsupium, it presents a very cognizable miniature of the parent. The development of a *Terebella* and of a Serpula, has been described by Milne Edwards; and there, too, he observed certain metamorphoses.

With regard to the class *Annulata*, generally we see that the metamorphosis varies much in degree: thus in the leech the embryo takes on almost at once the characteristic form of the parent; in other Annellata the ultimate form is obtained by a successive development of segments; while in others, again, there is more change of form in the course of developement. This should teach us caution in our generalisations as to the metamorphoses of particular classes. The chief point of interest in the developement of the Annellata is that the young of many species, when it has acquired the form of the parent, puts in action a power of parthenogenetic propagation by virtue of the retention of certain unchanged germ-cells or nuclei in the last integument of its body; that it does not develope male or female organs in its own person, but that these are developed in the young propagated by gemmation and spontaneous fission; so that in the Annulata we observe what Steenstrup calls alternate generation, although somewhat differently manifested than it was in the Entozoa or the Acalephæ.

William Tyler, Printer, Bolt-court, London.

1st April, 1885.

Dear Woodward,

Sorry I could not get to hear you last Wednesday; but look with interest to seeing your Paper in full with its illustrations.

Add to my debt for another Copy of your 'Guide to the Geology', wh. please to post to.

Yours sincerely,

Richd. Owen.

16th January, 1885.

Dear Woodward.

When the Australian fossils arrive I hope they may be found worth Barlow's attention.

The 'drawings' indicate a large Lacertian with horns, longer & more slender than in M. prisca.

A vertebra shows Megalanian

Sheen House, Sheen Gate, S. Sheen
8 January 1885.

Dear Woodward,

By inclosed it seems likely the Mus. may receive more parts of a Megalania, from a new Locality. If Mr. Fitzgerald's sending Hands to turn out I would come over to inspect the remains, some of which may be in condition to profit by your good Lapidary's care.

The

21st April, 1885.

Dear Dr. Woodward,

In reply to your question of the 20th inst. I have to state, that the Date, 1878, of the initial step taken in the acquisition of the Skeleton of a Rhytina is correct: my intention, in the event of such acquisition was, to place the specimen of that extinct species in the 'Department of Geology'.

Believe me,

faithfully yours,

Richard Owen.

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Yours sincerely.

Richd: Owen.

16th January, 1885.

Dear Woodward.

When the Australian fossils arrive I hope they may be found worth Barlow's attention.

The drawings indicate a large Lacertian with horns, longer & more slender than in M. prisca.

A vertebra shows Megalania

The Drawing alluded to might be posted here & I would return it, with any remarks of which it might be susceptible.

Mr. Wilkinson's crocodilian teeth may be Lacertian; but they can wait my seeing you, when weather & bronchite permit an issue.

Sincerely yours,

Richd. Owen.

21st April, 1885.

Dear Dr. Woodward,

In reply to your question of the 20th inst. I have to state, that the Date, 1878, of the initial step taken in the acquisition of the Skeleton of a Rhytina is correct: my intention, in the event of such acquisition was, to place the specimen of that extinct species in the Department of Geology.

Believe me,

faithfully yours

Richard Owen.

characters; a side outline
of, seemingly, part of a mandible
shows a large laniary tooth?
But I shall make the "personal
acquaintance" without prepossession. I still keep the fire-side,
& may not have leave to
emerge while winter weather
prevails. - Sincerely yours,

Richd. Owen.

Sheen Lodge, Sheen Gate, E. Sheen
8 January 1885.

Dear Woodward

By inclosed it seems likely the Mus.m may receive more parts of a Megalania, from a new Locality. If Mr. Fitzgerald's sending Prout to turn out I would come over to inspect the remains, some of which may be in condition to profit by your good Lapidary's care -

Yrs

Richmond Park.

21st April, 1885.

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Believe me,
faithfully yours,
Richard Owen.

The pregnant Uterus of Echidna, last described, is in a bottle of Spirits in a recess of the Osteol. Gallery - It might, safely, be kept with the Stuffed Monotremes. It would be out of sight in the host of Spirit Specimens.

Yr. ... indication of progress with an "Index Museum"?

Read

[illegible] May 1885

[illegible]

[illegible] reference to the Paper by Dr. Leidy

"Who proposed the name of Uintatherium

"for certain Specimens obtained by him"

(Geol. Mag. May, 1885, p. 213) – "procured

"from the Uinta chain on the South."

[illegible]

Yours sincerely,

R. Owen.

Richmond Park.

17th July, 1885.

Dear Woodward,

I will present a Copy of the Br. Vert. Rep^r. to your Department Library: keep the 6 Parts in your study 'till I communicate with Mm. Capelle whose transmission I know nothing of.

Tell you, Mrs W. & your Daughters give us the pleasure of dining here-

Speen Lodge
Richmond Park

21st July, 1885.

Dear Miss Woodward,

Your charming little Landscape was the most pleasing and lasting memorial of yesterday: the near stream and distant hills with the [illegible] broken ground brought my native environment to welcome memory. When your good

Father

Sheen Lodge
Richmond Park.

17th August, 1885

Dear Woodward

Will you, Mrs. W., and the two Daughters give us the pleasure of dining here on Thursday, 20th, at 6 p.m.? Coming as early as you please, in walking costume, for a stroll in park & garden, hoping for propitious Sunshine,

Ever Yours,

R. Owen.

13th December 1886.

My dear Woodward,

My reference to Newcastle had reference merely to the need & use of diagrams for Provincial courses of Lectures.

Lingard will have hospitable welcome, from

Yours ever truly.

Rich. Owen

Sheen Lodge, East Sheen, S.W.
11th September, 1885.

Dear Woodward,

Will you give me credit for 3/- to defray the inclosed, with any added debt that may have accrued, to the worthy Messenger?

I shall look in at the Museum ere the end of the Month, & repay; with thanks, (bringing the Packet from L. E.).

Sincerely yours,

Rich. Owen.

(Read)

[illegible] 1865

[illegible]

would you supply me with
a reference to the Paper by Dr. Leidy
"Who proposed the name of Uintatherium
for certain Specimens obtained by him"?

Father returns & finds himself
sufficiently free from 'Magazine
chains' I shall hope for the
pleasure of a holiday afternoon
with the 'Woodward Family' in
my verdant locality. Let the
day most convenient to "129,
Beaufort Street," be intimated
to me, and a hearty welcome
will be returned.

Again, thanking you, believe me,
sincerely your's.

Rich.d Owen.

Sheen Lodge
Richmond Park.

17th August, 1885

Dear Woodward

Will you, Mrs. W., and the two Daughters give us the pleasure of dining here on Thursday, 20th, at 6 p.m.? Coming as early as you please, in walking costume, for a stroll in park & garden, hoping for propitious Sunshine,

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I shall look in at the Museum ere the end of the Month, & repay; with thanks, (bringing the Packet from L. E.).

Sincerely yours,

Rich. Owen.

on tuesday, 21st? Coming as
early as convenient; we dine
at 6 p.m. & hope the weather
may tempt to a Stroll in Park
and Garden -

Recd, yesterday, a Box from
Sydney, with 'casts', which may be
Duplicates of those received in your
Depart. 'Nous verrons'.

Ever truly yours,

Richd. Owen.

Eleven Lodge
Richmond Park

17th August, 1885

Dear Woodward

Will you, Mrs W., and the two Daughters give us the pleasure of dining here on Thursday, 20th, at 6 p.m.? Coming as early as you please, in walking costume, for a stroll in park & garden, hoping for propitious Sunshine,

Ever Yours,

R. Owen.

---

13 December 1884

My dear Woodward

By reference to Howard's last reference should be made to the need + use of Diagrams for Provincial courses of Lectures.

Lingard will have hospitable welcome, from

Yours ever truly.

Richd Owen

Eleven Lodge
Richmond Park

21st July, 1885.

Dear Miss Woodward,

If your charming Landscape was to most pleasing and lasting memorial of yesterday, the real scene and distant walks with unbroken ground brought my native environment to welcome memory. When you pass

---

Eleven Lodge East Sheen.

11th September 1885.

Dear Woodward

Will you give me credit for ... defray the incidental, with any ... that may have occurred, to the ... worthy Messengers?

I shall look in at the Museum ... the end of the Month ... reports, ... Thursday, bringing the Lunch pan ...

Sincerely yours

Richd Owen

Read

[redacted]

17th May. 1885

Dear Woodward

I could you kindly refer me with reference to the Paper by Mr Eddy on "Diospyros" the name "Clintathecium" on certain specimens "Blaine Bayram" (Gard. Chron., 83 p. 213) presume "from the Clinta Chain on the South"

Yours

Sincerely

T. Caton.

[redacted]

17th July. 1885.

Dear Woodward,

I will present a Copy of the Br. Rep. Rep. to your Department Library: keep the 6 Parts in your Study 'till I communicate with Mr. Capelle whose transmission I know nothing of.

Will you, Mrs. W. & your Daughters give us the pleasure of dining here

Sheen Lodge
Richmond Park

21st July. 1885.

Dear Miss Woodward,

Your charming little Landscape was the most pleasing and lasting memorial of yesterday: the near stream and distant hills with intervening broken ground brought my native environment to welcome memory. When your good

Father

Sheen Lodge
Richmond Park.

17th August, 1885

Dear Woodward

Will you, Mrs. W., and the two Daughters give us the pleasure of dining here on Thursday, 20th

Ellen S. Woodward.
"Letters and Autographs of Zoologists with Biographies and Portraits." [Manuscript]. [19--?].

Ellen Woodward was the wife of Henry Woodward (1832-1921), Keeper of Geology at the British Museum (Natural History). She compiled the letters written by naturalists to her husband and herself into a collection of 12 scrapbooks and added photographs and biographical notes for each correspondent. One entire volume, which also contains many newspaper reports and caricatures, is devoted to her husband's colleague, Sir Richard Owen (1804-1892) the most eminent palæontologist of the 19th century. This opening contains a number of notes written to both Woodwards on both scientific and social matters.

QL26 W66 Rare Books/Special Collections, Blacker-Wood Manuscripts

of Lectures.

Lingard will have hospitable

Welcome, from

Yours ever truly,

Richd. Owen

thanks; (bringing the Packet from L. E.).

Sincerely yours,

Richd. Owen.

Sheen Lodge

8th October, 1885.

Dear Woodward,

If any of your Staff could be spared to call here, with a carpet bag, he might bring you the Casts of Nopits from Australia, and the Budget of Manx Drawings' Papers. (I am confined to the house.)

I have sent a Paper to the Geol. Soc. on the Wombat-like Phascolomys curvirostris, and would ask you (if you should attend that Meeting) to take the Cast & Photos on which that Species - (to modified as to indicate a generic distinction, say Phascolarctus) is founded. The casts of the big Kangaroo are of a Macropus Ajax.

Sincerely yours,

R. Owen.

I present them to the Museum.

12th October 1885.

Dear Woodward,

With Pleasure I introduce the Bearer Dr. Cowan - he has brought me some additions I believe to Megalania. You will have pleasure in making his acquaintance,

Sincerely yours,

Richd Owen.

Sheen Lodge
Richmond Park.

17th December, 1885.

Dear Woodward,

I have spent an interesting hour in contemplation of the Drawings you kindly sent. I make out an edentulous upper jaw, portions of skull with horn-cores, caudal vertebræ with their bony sheath, - all bespeaking a Megalania, but of a kind distinct from the continental prisca. I am not quite sure about parts, possible, of the

-Sheen, S.W.
1886.

have promised
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on the 28th., and
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Yours ever truly,
Richd. Owen.

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I presen
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mandible, and am left with a
longing to spend an hour or two
over the fossils, and shall pay
an early visit to the Museum.
A paper on subsidiary parts
of Meg. prisca, from Queensland
is finished, with outlines of the
parts deserving figures. I shall
have Erxleben, with me during
the Xmas week and he will draw
them - With many thanks, and
good wishes to the home-circle,

Sincerely yours,
R. Owen.

-Sheen, S.W.
1886.

have promised
d the Anniversary
on the 28th., and
e Dinner.
you kindly
y, begat the wish
al zoological
per on "British
my name that
designate those
e obtained by.

Yours ever truly,
Richd Owen.

Shenstone Lodge, 8th October, 1885.

Dear Woodward,

If any q
be spared to call h
he might bring you
from Australia, and t
Annings' Papers. I an
(I have sent a Paper
on the Wombat-like
rostris, and would ask (if you show
"Photos" on which th
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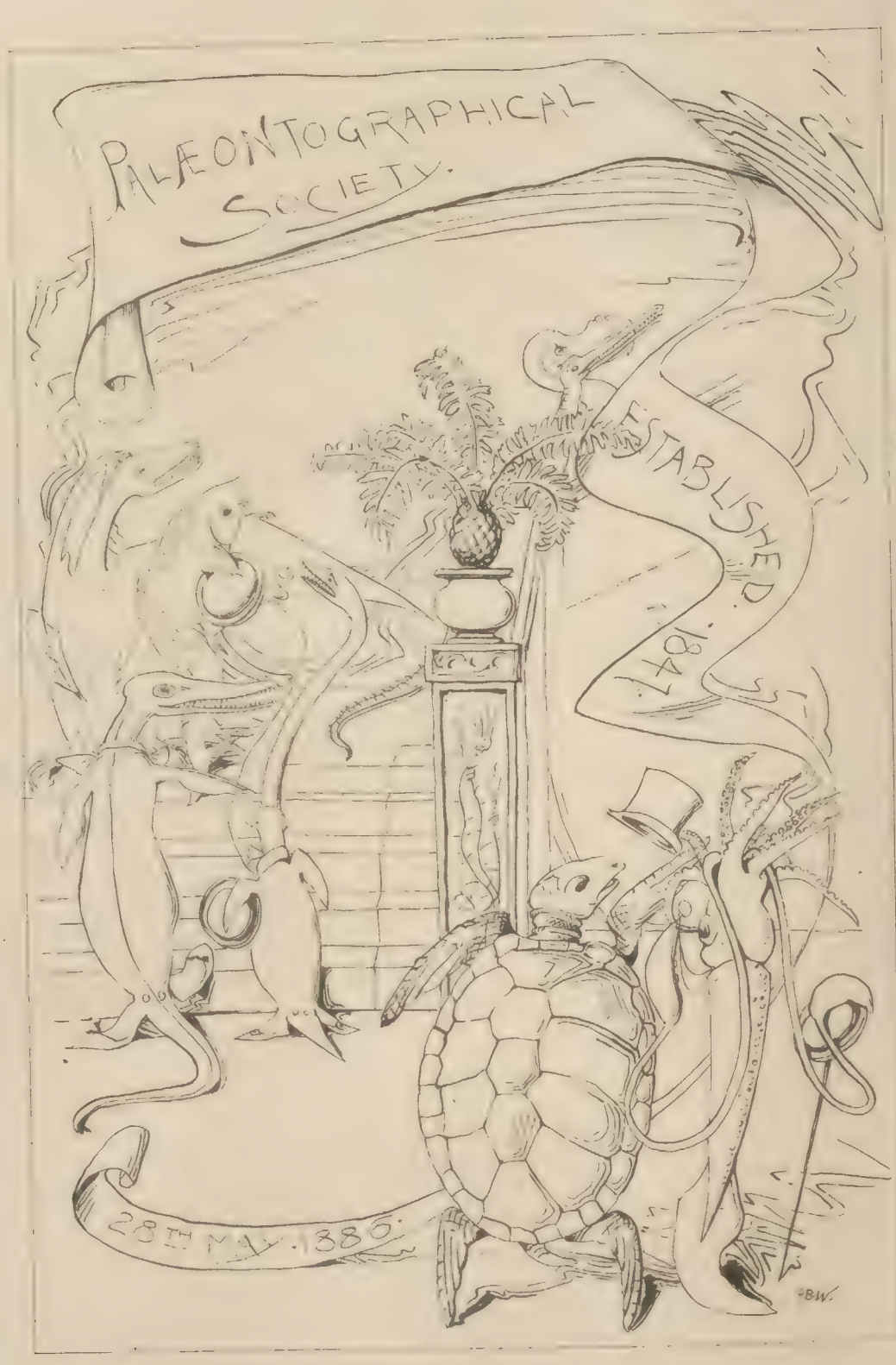
Phascolotictus) is fo
of the big Kangaroo re

Sincerely

R.O.

I present them
to the Museum



quite sure about parts, possible, of the

CONVIVII QUOD HABEBIT

SOCIETAS PALÆONTOGRAPHICA

Apud Hospitium cui "CRITERION" nomen est

PROGRAMMA

AD DIEM MAII XXVIII, A.C. MDCCCLXXXVI.

Viro Clarissimo RICARDO OWEN, K.C.B., Præside.

EPULARUM SCHEMA

Ab ovo usque ad mala.

PREFATIONES.

Salgama encrasicholorum—cum multis aliis.

JURA.

Purificatum Oweni. Consummatum vernale.

PISCES.

Salmo elixus garo Luculli subveniente.
Clupeæ infantiles, simplices atque diabolozatæ.

PAROPSIDES.

Coturnices communes ad agaricos.
Pancreata agnina modo Tolosæ redditæ.

RELEVATA.

Sella ovina fuscatim cocta.
Tubera esculenta. Legumina haricotiensia.

MENSA ALTERA.

Anaticulæ domesticæ ope pisorum perfectæ.
Pulluli granarienses. Acetaria.
Asparagi surcula.

TRAGEMATA.

Farcimen Tyroliense. Cremor Bavariense fructibus gaudens.
Dulciariæ diversæ. Glacialis Nesselrodica.
Bellaria. Kupha.

VINA INTERPRANDIALIA.

Rhenicum ad Hoc. Xericum. Campanense spumans.
Et quod ex Ædibus Margaviensibus "Claret."

SYMPOSIUM.

Nunc est bibendum. Cubito remanete presso.
Propinationes. Orationes.

In vino, merissimo vino, plurimæ deliciæ,
An dubitas? bibe, pocula te invitant.

Liber—si lætus aderit,

* * * *

Vivas producet lucernas
Dum rediens fugat astra Phoebus.

Sanctæ Nicotianæ Consolatricis Cultus.

IO BACCHE.

E. H. V.

-Sheen, S.W.
1886.

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Your's ever truly,
Richd Owen.

Sheen Lodge, 5th October. 1845.

Dear Woodwar

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Phascolotherium

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I present them
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(Private)

Dear Dr. Woodward,

Thanks for the (copies) of your two instructive Guide-books; remind me when I next visit the Museum of my debt. I add a separate Note for your 'Report' if it should be desirable to use it. I should be glad to see a duplicate skeleton of Rhytina in the Dep.t of Zoology; but I think the general

Sheen Lodge, East Sheen, S.W.
9th May, 1886.

Dear Woodward,

I have promised Prof. Wiltshire to attend the Anniversary Meeting of the Pal: Soc: on the 28th, and to take the Chair at the Dinner.
I confess that what you kindly shewed me, on Friday, begat the wish to take leave of the "Palæontological Series" by a Final Paper on "British Tropic Reptiles". Any name that might have appeared to designate those gems, would be retained by,

Yours ever truly,
Rich.d Owen.

Sheen Lodge, 5th October. 1885.

Dear Woodwar

I

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Annings' Papers

I have sent a

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Phascolarctus)

of the big Kangaro

Yours

I present them
to the Museum

opinion would be that the
'Geology' has the prior claim
for exhibition of the evidence of
an Extinct Species. Accordingly,
I hope that you may be able
to add the remains of both a
Dodo & a Solitaire to the
Division-Series.

The honour of having a 'Bust'
in a Gallery of the Museum can,
I think, be only conferred by the
Trustees.

Yours

quite sure about parts, possible, of the

Mr. Thornicroft, R.A. exhibited the satisfactory one which he executed a few years ago: of this I have a cast. (no. 2, Melbury Road, Kensington: you would be welcome, using my name).

Thanks for the summary of your Sirenological Memoir; it adds to my desire to see the full & illustrated issue.

Thanks, too, to a Woodwardian Artist of the life-restorations of extinct Amphibians.

Sincerely yours,

Richd. Owen.

Sheen Lodge, East Sheen, S.W.

9th May, 1886.

Dear Woodward,

I have promised Prof. Wiltshire to attend the Anniversary Meeting of the Pal: Soc: on the 28th, and to take the Chair at the Dinner.

I confess that what you kindly shewed me, on Friday, begat the wish to take leave of the "Palaeontological Series" by a Final Paper on "British Tropic Reptiles". Any name that might have appeared to designate those gems, would be retained by,

Yours ever truly,

Richd. Owen.

Sheen Lodge
Richmond Park.

20th January 1887.

Dear Woodward,

Herewith you have the 'Testimonial' which I feel to be an act of justice, affording me pleasure, to place at our worthy Friend's service. I leave to you to add the date.

The grandson - Basil Lettsom Owen - who began to hunt for fossils before he was entered at Merchant-Taylors', will be a year & some months

Sheen Lodge, East Sheen, S.W.
15 February, 1887.

Dear Woodward,

Since I last saw you my dear Sister's strength began to fail, and She has passed peacefully to rest, having nearly completed her 90th year. I had intended, till in close attendance upon her, to write and ask if you could spare your dear Daughter's time to make a Drawing of the Base of the well-worked out Skull, and of the Back-view of the other Skull of Meiolania.

Will

Sheen Lodge, Richmond Park,
28th February, 1887.

My dear Woodward,

I was gratefully surprised at the sight of Mr. Hall's work when last in your Studio, I am still more astonished at the 'casts' which you have kindly sent. They will enable me to revise my letter-press and send it with more confidence to the R. S.

If I could add one or two

Sheen Lodge, East Sheen, S.W.
19th March, 1887.

Dear Woodward,

Accept sincere acknowledgments of your & friend Davies's kind suggestions: they are unique exceptions to the spirit and way in which my mistakes - real or alleged - have hitherto been dwelt on.

Thanks to the Drawings of my valued friend yours accomplished Daughter, I have been enabled to complete my second Mēwlanian Paper; in which, among other

Sheen Lodge
Richmond Park.

20th January, 1887.

Dear Woodward,

Herewith you have the
'Testimonial' which I feel to be an act
of justice, affording me pleasure, to
place at our worthy friend's service.
I am [illegible] Field Student

pleasure I will defray for both
time and talent.

With kindest regards to her and you,
I remain,
most truly yours,
Richard Owen

Sheen Lodge, Richmond Park,
28th February, 1887.

My dear Woodward,

I was gratefully surprised at the sight of Mr. Hall's work when last in your Studio, I am still more astonished at the 'casts' which you have kindly sent.

examples of Chelonian affinities, I have noted – with accompanying figures – the modifications of vertebræ in one of the same column – "procoelian", "opisthocoelian" "biconvex" –, of which, hitherto, I have noted such character in certain existing Members, exclusively, of the Chelonian order of Reptiles. I hope to send in the Paper in a few days.

Could you oblige me with the loan of a skull of any recent Chelonian? I could then go over the characters which I have had to refer to from memory only.

Sincerely yours,

Richard Owen.

Sheen Lodge
Richmond Park.

20th January 1887.

Dear Woodward,

Herewith you have the 'Testimonial' which I feel to be an act of justice, affording me pleasure, to place at our worthy Friend's service. I leave to you to add the date.

The grandson - Basil Lettsom Owen - who began to hunt for pupils before he was entered at Merchant-Taylors', will be a year & some months

having nearly completed his 90th year. I had intended, till in close attendance upon her, to write and ask if you could spare your dear Daughter's time to make a Drawing of the Base of the well worked out Skull, and of the Back-view of the other Skull of Meiolania.

W.H.

Drawings by my friend – your accomplished Daughter – my satisfaction in a – probably – concluding paleontological Work would be complete.

Again, with thanks & deep sense of obligations, believe me,

Ever truly your's,

Richard Owen

Sheen Lodge, East Sheen, S.W.
19th March, 1887.

Dear Woodward,

Accept sincere acknowledgments of your & friend Davie's kind suggestions: they are unique exceptions to the spirit and way in which my mistakes – real or alleged – have hitherto been dwelt on.

Thanks to the Drawings of my valued friend yours accomplished Daughter, I have been enabled to complete my second Mèwlanian Paper; in which, among other

under the age at which he could
be appointed to an Assistantship:
I am sorry for it, because, if his
life be spared, he will, I think, leave
his mark on our favorite Science.
Thank you, dear Woodward,
for your friendly intimation of
the coming vacancy in your
Department; and,
believe me,
ever sincerely your's,
Richard Owen.

Green Lodge, Richmond Park.
28th February. 1887

My dear Woodward,

Of course I was greatly surprised at the sight of Mr Hall's work when last in your Studio. I am still more astonished at the casts which you have kindly sent. They will enable me to revise my letter-press and send it with more confidence to the R. S.

If I could add one or two

Green Lodge East Sheen S.W.
15 February, 1887.

Dear Woodward

Since I last saw you my dear Sister's strength began to fail and She has passed peacefully away having nearly completed her 96th year. I had intended, till in close attendance upon her to write and ask if you could arrange your dear Daughter's time to make a Drawing of the Base of the end one cast Skull, and of the Back view of the other Skull? Remember me

Green Lodge East Sheen, S.W.
19th March 1887.

Dear Woodward,

I must write and thank you for your kindness in sending me your Drawings of the Skulls. They are very successful and will be of great service to me in the Work I am now engaged upon. I have also received the Photographs which you kindly sent me. I am very much pleased with your account of your Daughter's progress. I have been unable to complete my Address to the Section of Anthropology, in which among other

Sheen Lodge, East Sheen.
6 April, 1887.

Dear Woodward,

My 2d. Paper on Meiolania has gone to the R.S.

I don't remember whether I told you of my reception of casts of the Skull, atlas, tibia and perfect humerus of Echidna Ramsayi. The mutilated bone on which the Species was founded is figured in Phil. Trans. Part 1, 1884.

I hope I had the grace to send you a copy! What I now greatly need, and long for, are, the above-named bones of Echidna hystrix: they would be thankfully returned, by,

Yours ever truly, Richd. Owen.

Sheen Lodge., 8th. April, /87.

Dear Woodward,

Thanks for the kind transmission of the casts of the fossils of Echidna, including that of the subject of Figs. 1-3, Pl. 14, Phil. Trans, 1884. Thinking you might have duplicate bones of Ech: hystrix, not enter'd into the "Mus: Catalogue", I ventured to ask for the loan thereof, for comparison with casts of parts of the Skeleton of Echidna Ramsayi, lately sent to me and affording acceptable additions to its osteology.

To whatever Order Meiolania may be referred Megalania must go with it.

But neither carapace nor plastron of either genus has yet appeared, to; Yours most truly, Richard Owen.

HUNTERIAN LECTURES

ON THE

GENERATION AND DEVELOPMENT OF THE INVERTEBRATED ANIMALS.

By RICHARD OWEN, F.R.S.,

HUNTERIAN PROFESSOR AND CURATOR OF MUSEUM OF ROYAL COLLEGE OF SURGEONS, CORRESPONDING MEMBER OF THE INSTITUTE OF FRANCE, &c.

[*Reported expressly for the Medical Times, and revised by the Lecturer.*]

LECTURE XI.

GENERATION OF EPIZOA AND CIRRIPEDIA.—General characters of these parasitic Articulata.—Arrested development of the dwarf-males of Epizoa.—Male organs of Achtheres.—Complex female organs of Epizoa: their external ovisacs.—Development of embryo and retrograde metamorphosis of the young into the adult animal.—Organs of generation of the Cirripedia: conflicting opinions respecting them: they are androgynous.—Dendritic testes: glandular sperm-ducts and long proboscidiform penis — Ovaria; their different position in sessile and pedunculate Cirripeds: extreme metamorphosis in this class.

MR. PRESIDENT AND GENTLEMEN,—The phenomena of the generation and development of the animal kingdom, so far as we have traced them, must, already, have impressed us with the inadequacy of the knowledge of the nature of an animal in its final and complete stage of existence only, for the determination of its affinities and proper place in the scheme of Nature. This fact was demonstrated with regard to many of the previous objects of our study: it is still more obvious in respect of the class of animals which will occupy our attention to-day. I may also here observe, that whilst it is essential to trace the metamorphoses of each species in order to rightly comprehend its true nature, the study of the generative organs shows that we cannot rely on them alone for a system of classification. We saw, for example, that some of the anellides combined both male and female organs in the same individual, while others had those organs separate and peculiar to distinct individuals; one order was androgynous, another dicœcious. In the earth-worm we had evidence of a certain concentration of the generative system within a few segments, and in the leech, of their more general diffusion and subdivision; but this vegetative character was most remarkable in the dicœcious annellides, in which almost every joint presents either its pair of testes or of ovaria, according to the sex of the individual. Then, in reference to the progress of development of these worms, some transitorily manifested the form and character of one class, inferior to them in the animal scale, and others those of another lower class; thus, the embryo leech represented the planaria, whilst most of the higher annellides come forth from the ovum more like infusorial animalcula. The further progress of development was interesting, since it reminded us of that singular propagation of certain Acalephæ, in which the larva produced other larvæ like itself, before it was metamorphosed into the final form of a medusa. For the ordinary mode of growth of the Annellide, by the development of joint after joint, one precisely similar to the other, throughout a series of, perhaps, hundreds of joints, with only the first and the final segments distinguished by any peculiar characteristics,—all this process of growth looked very like an incomplete parthenogenesis: but this mode of production is fully manifested by the successive casting off of groups of segments, with the characteristic head and tail, as in the instances of gemmation of the naids and nereids last described; the young annellide from the ovum propagating at first by gemmation and spontaneous fission; and the individuals so produced developing the ordinary organs of generation.

The low organized articulated classes, which succeed the annelides in the progress upwards, undergo such extraordinary metamorphoses before attaining their mature state, as to mask their true relations, not only to the class, but to the primary division of animals to which they belong. This is especially the case with the creatures whose organization and developement will form the subject of the present lecture.

This elongated, cylindrical, unarticulated Lernæa, (showing the preparation,) whose smooth soft body seems devoid of any other appendages than the two long slender ovisacs, might be regarded as one of the Entozoa of the fish to which it is attached, and on the nutrient juices of which it subsists.

This barnacle, imprisoned in its conical calcareous shell, and cemented to the stone on which it grew, might seem as naturally to belong, like its neighbour the limpet, to the testaceous Mollusca.

How minute and accurate must have been the investigation of the forms and structures of these animals, at every stage of their existence, before the truth could be discerned, that they were more nearly allied to one another than to any other class of animals! The most vivid imagination of the boldest generaliser or speculator upon the unity of organisation in the Animal Kingdom could never have divined that the Lernæa and the Cirripede were at one period of their lives locomotive animals, swimming about under very similar forms, and by almost identical natatory instruments,—not under the common ciliated infusorial form, in which the young of certain Entozoa and Mollusca first enter into active life; but with symmetrical pairs of jointed setigerous legs like those of the Annellides and the lower organised Crustaceans, to which the *Epizoa* and *Cirripedia* are, in fact, essentially and most closely allied, although they end their career as sedentary animals under such different, such diversified, and, as regards the Epizoa, such grotesque forms.

These metamorphoses lead to very different results from those of the Medusa and Comatula. The Epizoa and Cirripedes acquire increase of bulk and organs of generation; but, in every other respect, the varied course of their development ends in a retrograde movement. Their development would seem to have been at first, as it were, hurried forward at too rapid a pace, and the young parasite, starting briskly into life, ranging to and fro by the highest developed natatory organs we have yet met with, and guiding its course by visual organs, must lose its eyes and limbs before it can fulfil the destined purpose of its creation.

The *Epizoa*, by which name we recognise the singular class of animals which infest the skin, the eyes, and the gills of fishes and other marine animals,—these external parasites, which are as numerous as, and perhaps more numerous than, the whole class of fishes,—are distinguished in their mature state by a body of a more or less elongated or sub-cylindrical form, defended by a smooth, semi-transparent, parchment-like integument, having a more or less distinct head, and generally a pair of long cylindrical ovisacs, dependent from the opposite extremity of the body.

In this low organised class of Articulate animals, as in the classes which commence all other great primary groups, there is an extensive gradation of forms by which we pass from species slightly elevated above the cavitary Entozoa to the true Crustaceans.

The lowest or most simple Epizoa adhere by a suctorious mouth, and traces of extremities exist only in the form of a few minute pairs of obtuse inarticulate processes. In the highest organised species, the adhesion is effected by jointed mandibles with terminal hooks or forceps. The head, in most of the species, is found, when closely examined, to present a pair of jointed antennæ, which, contemplated by the experienced naturalist, cognizant of the value of such characters, might excite the suspicion that relations to higher *Articulata* than the Anellides were hidden under the bloated form which indolent and gluttonous habits had superinduced upon the pendent parasite. Observation of it during its early and independent state has proved this to be actually the case to an extent which could scarcely have been anticipated.

The Epizoa are of distinct sexes: the male appears always to retain his freedom, and is, perhaps on that account, singularly smaller than the female, generally not more than a fifth part of her size; consequently, for a long time, the males escaped recognition. They adhere to the vulva with one antenna usually inserted therein. The individuals of the productive sex, distinguished throughout a great part of the year by their pendant ovisacs, are the examples usually seen of this curious class; and in these I shall proceed to describe the anatomical characters of the Epizoa.

The body, independently of the ovisacs, is generally divided into two segments: the anterior and

smaller division sometimes supports a distinct head, but more commonly corresponds with the cephalothorax of the Crustacea: the larger segment is called the abdomen, and in it the ovaria are developed. You will not unfrequently find adhering to the eye of the sprat an Epizoon or Lernæa, which is a nearly allied species of the same genus (*Peniculus*), as the specimen figured and described by Nordmann, which infests the boar fish (*Zeus aper*) In the *Peniculus fistula* the head is oval, and notched anteriorly, each division being armed with an inwardly bent hook, or rudimental jaw. The mouth is immediately beneath these, in the form of a circular orifice, supported by a short cartilaginous tube. At the posterior contracted part of the head are two pairs of short, oval, flattened processes: a constriction or neck separates them from the thorax, at the commencement of which there is a third pair of similar rudiments of locomotive appendages. The thorax is round, and separated by a constriction from the abdomen, a fourth pair of appendages being developed from the interspace. The alimentary canal is much contracted in the neck and thorax, but expands in the abdomen into a moderately wide and uniform intestine, which again slightly contracts to terminate by a distinct anus at the hinder extremity. The alimentary canal has the same simple straight course in other species of Epizoa. One cannot be surprised at this correspondence with its general condition in the cavitary Entozoa, when the similarity of their easily assimilable nutriment is remembered. The intestine, is, however, complicated in the Epizoa, with a conglomerate or minutely-lobed glandular mass, developed from nearly the whole extent of the abdominal tract of the intestine, and which may fulfil the function of a liver.

In some species which attach themselves to the gills and the like favourable positions for an abundant supply of the most nutritious fluid, the body is frequently deformed, as it were, by excessive growth, and cæcal productions from the simple straight intestine are continued into the prolongations of the thoracic or abdominal walls. The Nicothoë, a small parasite of the gills of the lobster, is an example of this condition of the digestive organ. The first segment of the body is produced into two lateral symmetrical wing-shaped lobes, each four times the length of the segment to which they are attached, and they contain corresponding cæcal prolongations of the straight intestine.

In the species of Lernæa exhibited (*Peniculus fistula*), the abdomen contains, in addition to the alimentary canal, two slender tubes, the ovaria and oviducts, commencing by blind extremities near the anterior part of the dilated intestine, and continuing with a slightly wavy course to terminate at the two apertures, to which the ovisacs are attached.

These ovisacs singularly resemble the seed-capsules of certain plants, especially the *cassia fistula* being divided into a series of cells or chambers by transverse septa, placed at regular distances. Each cell contains an elliptical or lenticular ovum.

Two slender white filaments running almost parallel with, but at a distance from, each other, through the whole length of the under surface of the abdomen, nearer the margins than the middle line, form the chief and most conspicuous part of the nervous system.

The Epizoa differ from one another in their mode of adhering to the fish they infest: some stick fast by a suctorial mouth; others by processes that grow from the head: but the most common mechanism of adhesion in the Epizoa is a circular sucker, developed upon the confluent extremities of a pair of obscurely jointed tubular feet, the third thoracic limbs of the larva, — as in this *Lerneopoda* of the shark, (showing No. 286 A,) and as in the *Achtheres* of the Perch, the *Tracheliastes* of the Chub, &c. In the last-named parasite, which may be found adhering to the fins of the Chub in the months of October and November, the head and thorax are confluent, unless the segment to which the bases of the before mentioned feet are attached be held to represent the thorax. The abdomen is, as usual, the largest segment. The mouth is a circular aperture, fringed with minute short bristles; on each side there is a maxilla dentated at the inner margin, and terminated by a bifid hook. The antennæ are represented by two short lancet-shaped processes, terminated at the apex by a few extremely short bristles. The most conspicuous appendages of the head are, however, a pair of mandibles, which consist of two obscure joints, the second of which has a bifid extremity; the outer division is armed by a strong curved spine, which is opposed to two short straight spines; the inner division is tipped with four small spines. Immediately behind the large tubular prehensile process is a short rudimental extremity, supporting a moveable hook, which is opposed, as in the mandibles, by two short spines. The muscular system is sufficiently conspicuous in the head of this Epizoon in the form of distinct fasciculi of fine fibres.

In this *Penella* (showing No. 286) the head resembles a cauliflower, swelling out into a globose groupe of slightly branched and obtuse wart-like processes, which must have grown after the head had become imbedded in the flesh of the fish to which it is attached. Two long tubular processes or extremities are developed at the junction of the thorax with the abdomen; but their extremities are free, simple, slightly attenuated, and obtuse. On the under surface of the body, in the interspaces of these appendages, there are four pairs of simple, small, oval, flattened feet; their pointed extremities extend only half way to the sides of the part of the body to which they are attached. The body is prolonged beyond the ovisacs in the form of a tail, which is provided on each side with a series of sixteen slender cylindrical appendages, close set in an oblique position, like the barbs of a feather, or the vane of an arrow, whence the specific name *Sagitta*, given to this parasite. The caudal lamellæ of the higher Crustacea would seem to be here sketched out.

The anatomy of the Epizoa has been most elaborately traced out by Nordmann in the parasite of the common perch, called *Achtheres*. In this species two lateral teeth project from the circular mouth, the labial margin of which is fringed with bristles. Here, also, we have mandibles and maxillæ, the latter provided with palpi; and, besides these, a pair of jointed antennæ, each terminated by three setæ. Now, this is a very important external character; it is the first instance of true jointed antennæ that we have met with in our ascending survey, and the acute zoologist might be led to surmise, from their presence, that relations of higher affinity were masked beneath the general character of the vermiform body of the parasite, and we shall be able to raise the mask as we trace the metamorphoses of the species.

The circulating fluid consists of a clear plasma, with granular corpuscles of different forms and sizes. The pulsatile vasiform heart may be seen at the middle line of the cephalo-thorax propelling the blood forwards by rythmical contractions. Two canals pass from it into the hollow prehensile feet. The rest of the blood is distributed to the head, and along each side of the commencement of the alimentary canal to the under part of the body, where it passes backwards in the vessel which accompanies the intestine.

The ovaria at first appear in the form of a slightly flexuous, long, blind tubes, sacculated along one side. As the ova are developed, the ovarium takes on the form of a bunch of grapes, and occupies the whole cavity of the abdomen external to the intestine: each ovarium terminates by a triangular, and somewhat prominent orifice, to which the external ovisac is appended.

The Epizoa are remarkable for the disproportionate size of the sexes. In the minute male, the testes are indicated by four dark-coloured and finely granulated bodies situated in the posterior segment or abdomen. He appears like a mere parasite of the female to which he adheres, near the vulva, and having usually one antenna inserted into that aperture.

The first remarkable circumstance in the natural history of the aquatic Epizoa is the constancy with which particular species infest particular fishes or crustacea. And how, it may be asked, can creatures so devoid of means of transport, nay, in most instances, of the power of detaching themselves from the animals whence, like fœtuses, they derive their means of growth, originally reach the precise species of animal and organ to which they are habitually attached?

Are certain of the ova accidently retained near the parent after the rupture of the ovisac, and there grow, like seeds of plants fallen in a favourable soil? Or, do some of the liberated ova, by a happy fortuity, arrive at the appropriate organ of the appropriate species, and are they there accidentally retained until the prehensile instruments are developed? Such hypotheses may be permitted in reference to the ova of an Entozoon which are developed by millions, and need only to be swallowed by the animal in whose intestine they are adapted to exist; but the ova are too few in the Epizoa, and the parts to which they are attached are too exposed, to allow of the supposition that their parasitic growth is dependent on such accidental circumstances.

MM. Audouin and Edwards appear to have been the first to suggest that the sedentary Lernæan Epizoa might enjoy at a previous period of existence locomotive powers, and the hypothesis was supported by the discovery, made by Dr. Surriray, of the embryo of a *Lernæocera*, still in the ovum, which, instead of resembling the parent, presented the characters of a locomotive Entomostracous monoculous Crustacean.

The singular metamorphosis thus indicated has been traced out and generalised by the careful observations of Dr. Nordmann. The following is the general course of development of the Lernæan parasite of the Perch.

The female Achtheres is devoid of ovigerous appendages in the months of December, January, and February. In March they are developed by the eversion of a membrane prepared in the ovarian sac. Each sac hangs by a short tubular peduncle which is in direct communication with the short oviduct. The outer membrane of the ovum or chorion is moderately thick and transparent; the inner membrane is thinner, and includes both the vitelline mass and albumen. The yoke forms the largest proportion of the contents of the ovum, and is finely granular. One of the first parts of the embryo discerned by Nordmann was the dark ocellus. A pair of cylindrical processes shoot out from each side of the fore part of the embryonic or vitelline mass; and a pencil of hairs is developed from the extremity of each process. The body slightly elongates; the exterior albuminous fluid increases, the inner membrane expands, and the outer one bursts and is shed. The movements of the imprisoned embryo increase in force until it bursts the remaining membrane of the ovum, and escapes from the ovigerous sac. It then presents the form represented in the diagram. The locomotive organs are in two pairs, and consist of tubular processes of the integument, including a fasciculus of bristles. You perceive that these locomotive organs present the type of the Annellida. And since we were led from the Infusoria to the Polypi, because the ciliated larvæ of these resembled the monads, and since we passed from the Polypi to the Acalephæ, because these in their larval state were polypes, so we have now the same indication from a transitory step in development for passing from the Annulata to the Epizoa, and for ranking these parasites on a higher step of articulate structure; and not with the Entozoa, where Cuvier and Lamarck left them.

In the course of half an hour the young *Achtheres* undergoes its second stage: the first integument is loosened by the formation of a second beneath it, which now incloses a body, altered in its shape and in the number and nature of its appendages.

The process of moulting lasts from eight to ten minutes. A great proportion of the original germ mass remains unaltered, surrounding the simple intestine, and extending into the bases of the tubular feet of the larva. The *nisus formativus* proceeds to operate on this material, but on a modified plan. The second body, which is formed inside the husk of the first, now cast off, is divided into an anterior and

a posterior segment, the latter consisting of four joints. A pair of four-articulate setigerous antennæ diverge from the anterior part of the body. Between the antennæ is the large single median eye, as in the monocular Entomostracous Crustacea. The little Epizoon is now provided with five pairs of feet, the first three pairs terminate by a simple hook; the last two pairs are bifurcated, one division being hooked and prehensile, the other tubular and emitting tufts of bristles; these natatory feet strike the water together, and propel the body forward with a jerk; they are aided by the last segment, which is terminated by four setigerous tubercles.

The antennæ probably serve to indicate to the young parasite its appropriate object, to which it then proceeds to attach itself. The first pair of feet is approximated towards the mouth, and forms the uncinated mandibles. The second pair of feet increases in size, and the terminal hook enlarges; they serve to seize and hold on to the surface of the fish selected. The feet of the third pair lengthen and unite together to form a cartilaginous circular sucker, and permanently anchor the parasite to its prey.

The two sexes are alike in their young and locomotive state: the male at its final metamorphosis retains the first pair of feet as mandibles, very similar in form to those of the female: the second pair is shorter and thicker: the legs of the third pair always remain separate from each other, and consists usually each of two large joints, the last one terminated by a claw. The posterior natatory feet disappear in both sexes; and, with the loss of these instruments of locomotion, the eyes, also, are blinded and absorbed.

Before proceeding to the *Cirripedia*, I would offer a few remarks on the real nature of the changes just described. They are commonly spoken of under the same name as that given to the changes of insects, and perhaps they differ only in degree. The metamorphosis in all insects is attended with the casting off of a certain proportion of the precedent individual, called the "moult," or the new animal may be said to creep out of the old, from which the process is called the "ecdysis." With regard to the so called metamorphosis which issue in the succession of a fixed, blind, sessile multivalve barnacle to a free-swimming crustacean with pedunculated eyes, or in the succession of a rooted vermiform parasite to a natatory animal with articulated setigerous limbs. When these phenomena are closely traced, they are seen to depend in a greater degree upon the action and coalescence of retained cells, than upon a change of form of pre-existing tissues. If the development of the ovum in the pedunculate ovarian sac of the low crustaceous external parasite of a fish be closely traced, the peripheral cells of the germ-mass are seen to combine and coalesce to form the smooth transparent skin of the embryo Lernæa, from which also tubular processes extend in two (*Achtheres*) or three (*Lernæocera*) pairs, including setæ which project from their extremities.

In the *Lernæocera* the anterior pair is directed forward like antennæ, but they are unjointed; and the head is further indicated by a coloured eye-speck. Another layer of germ-cells have perished, as such, in order to form the parietes of a straight and simple intestine, with a mouth and anus. Thus the annelidous type is first manifested.

But a large proportion of the minute germ-cells remain in the wide abdominal interspace, amassed around the alimentary tube, and aggregated in groups at the base of the tubular and setigerous feet. With respect to the latter, we might say that the same provision is made for the reproduction of the limbs as is retained throughout life in regard to those of the lobster. In the larval Lernæa, however, those reserve-cells commence the formation of new limbs irrespective of any injury to the old ones. The whole peripheral stratum of the retained germ-mass, in contact with the primary integument, is transformed into a new integument. These germ cells have increased and propagated at the expense of the aliment assimilated by the alimentary canal. The formation of the new integument and of the new feet proceeds connectedly and contemporaneously; but the new parts are not moulded upon the inner surface of the old ones. The plastic force has changed its course of operation. A hinder segment of the body is added to the front one, which answers to the whole of the body of the first larva. If antennæ did not before exist, a jointed pair is now developed. Instead of two pairs of tubular setigerous limbs, three pairs of uncinated prehensile limbs are developed from the anterior or cephalothoracic segment, and as many pairs of articulated setigerous limbs from the abdominal segment. New muscles, new nerves, and new vessels are formed for the support and exercise of these various instruments. The outer case, and all that gave form and character to the precedent individual, perish and are cast off; they are not changed into the corresponding parts of the new individual. These are due to a new and distinct developmental process; rendered possible through the retention of a certain proportion of the unchanged germ cells. The process is essentially the same as that which developes the cercariform larva of the Distoma within the gregariniform one, or the external bud from the Hydra, or the internal bud from the Aphis. It is a slightly modified parthenogenesis; and the phases by which the locomotive annelidous larva of the Lernæa passes through the entomostracous stage before retrograding to the final condition of the oviparous, limbless, bloated, and rooted parasite, are much more those of a metagenesis than a metamorphosis.

I now proceed to the second class of Articulated animals, which I here groupe with the Epizoa.

Many of the *Cirripedia* are parasitic animals, like the *Epizoa*, but are dependent upon the organized bodies to which they are attached for their place of residence, not for their food; those species which do not infest other animals are attached to sea weed, floating timber, or rocks. The Cirripeds are symmetrical animals, with a soft, inarticulated body enveloped in a membrane; they are provided with six pairs of rudimentary feet, obscurely divided into three joints, and terminated each by a pair of long and slender many-jointed, ciliated tentacles, curled towards the mouth, and thence giving origin to the name of the class. They are androgynous.

The mouth is, in most species, provided with a broad upper lip, with two palps or feelers, and three pairs of dentated and ciliated jaws. The opposite extremity of the body is prolonged into a slender, many-jointed, ciliated caudal appendage, which is traversed by the generative canal. The mouth is situated near the anterior extremity of the body, which is modified to form the organ of attachment of the animal. It is sometimes produced to a considerable extent, and is of contracted diameter, forming a long and flexible peduncle; sometimes it expands at once into a broad disc or basis of adhesion. The Cirripedes are divided according to these modes of attachment into two primary groups, viz., the pedunculated, or *Lepadoids*, and the sessile, or *Balanoids*. The first are commonly known by the name of Barnacles; the second by that of Crown-shells or Acorn-shells.

Most of the Cirripedes have their visceral cavity protected by a calcareous shell composed of many pieces; but in some, as the *Otion*, the membranous or pallial investment of the viscera is protected only by an elastic, horny sheath, continued from the epidermal covering of the peduncle. Two small calcareous bodies, developed in the substance of the outer envelope, just above the brachial fissure, are the sole rudiments of a shell in this genus, the horny covering of which is produced at its free extremity into two cylindrical processes. In the genus *Cineras*, the external tunic is strengthened by five calcareous bars, two at the ventral fissure, giving outlet to the arms, two along the terminal margin of the tunic, and one along the dorsal aspect. In the common Barnacle (*Lepas anatifera*), the calcareous matter extends from five centres, so as to protect the whole of the body, which is appended to the peduncle; the cephalic pair of valves, or that which is attached to the peduncle and defends the head, is the largest; the single dorsal piece has been compared by Cuvier, who retained the Cirripedes among the Mollusca, with the symmetrical dorsal-valve in the shell of the Pholas. All the valves are strongly marked with lines of growth, formed by successive additions to their margins, as in the shells of Mollusca. In the Pollicipes, there are other smaller calcareous plates arranged round the junction of the body with the peduncle.

All the sessile Cirripedes are strongly defended by a multivalve conical shell. The base of the shell is usually formed by a calcareous plate, and the walls are apparently divided into twelve conical compartments, six of which rise from the margin of the base, and terminate in a point at the free margin of the shell; whilst the other six, in the form of inverted cones, occupy the interspaces of the preceding series. This calcareous citadel is divided into six pieces by six sutures; the symmetry or bilaterality of the shell is determined by the dorsal piece being actually what each of the six pieces of the first series seem to be, viz, a simple triangular plate with its apex upwards: the two lateral pieces on each side consist each of the erect and inverted triangular piece closely united together; the ventral piece consists of one erect and two inverted triangular pieces, united inseparably in the mature Balanus. The whole shell has a cellular and organised texture, and its gradual expansion is provided for by the successive growth and calcification of processes of the mantle which penetrate the uniting sutures. The cone is lengthened and widened below by successive additions to its base, and is widened superiorly by the gradual increase in breadth of the wedge-shaped pieces of the second or inverted series. In the *Tubicinella*, (showing Prep. No. 279.) a parasitic balanoid of the whale, the compound shell is a long subcylindrical tube, reminding us of that of an amphitrite, but the animal, in both sessile and pedunculate Cirripedes, is fixed to the bottom of the shell with the head downwards.

Although the Cirripedes in their mature state possess no distinct organs of sight or hearing, yet they are endowed with sufficiently acute sensation to retract their cirri, and, if sessile, to close their opercules, at the sound or vibration of an approaching footstep; the same actions indicate that they appreciate the atmospheric movements produced by the approximation of the hand, even, according to Dr. Coldstream, when it is not brought nearer the shells than twelve or fourteen inches.

The marine animalcules brought to the mouth by the currents of the cirrigerous feet and seized by the lateral jaws, are conveyed by a short œsophagus to a dilated stomach, which receives the ducts of two salivary glands. Groups of hepatic cæca are developed from the walls of the stomach. The intestine is bent upon the stomach, and tapers with a slightly sinuous course to terminate at the base of the caudal appendage. According to M. St. Ange, the intestinal canal of the *Lepas* contains a membranous tube, which is continued above into the secerning cells in the walls of the stomach; it may be the detached epithelium; it has been deemed analogous to the typhlosole in the earth-worm's intestine.

A dorsal vessel and circulating currents along a double canal in the arms have been recognised; but the circulating system has not been thoroughly investigated. In the pedunculated Cirripedes slender conical branchiæ are attached to the base of the maxillary foot, and to that of some of the cirrigerous feet. The ordinal distinction between the pedunculated and sessile Cirripedes is not less strongly manifested by their outward forms than by the branchial organs, which, in the Balanoids, consist of two or more broad, transversely plicated, vascular membranes, attached to the inner surface of the mantle.

The organs of generation in the Cirripedes have been differently described by different authors. If the Cirripede be diœcious, and the males be free and of a disproportionately minute size, as in the Epizoa and in most Entomostraca, to which the Cirripedes are closely allied, we must then regard the organs of generation in the large attached individuals under a different and more simple point of view than they have hitherto been described. The males are, however, wholly hypothetical. In the pedunculated Cirripede, a large granular, glandular

mass covers the viscera immediately beneath the muscular tunic of the body, extending from the mouth to the anus. Its numerous ducts successively unite into three or four principal trunks, which terminate in a lateral receptacle at the side of the intestine. In *Lepas* a duct is continued from this receptacle on each side, which ducts unite to form a common tube, which passes through the canal of the extensile tail. In *Otion* the two canals are continued distinct to the extremity of the process. The walls of the receptacle, which is the common termination of the ducts of the lateral glandular body, are thick and glandular.

According to Cuvier and Dr. Burmeister, these glandular parietes of the ducts of the gland constitute the testis, and the glandular mass itself is the ovary. The ova are impregnated in the course of their passage through the common receptacle, and the duct continued from it.

On the diœcious hypothesis, we must suppose that the large fixed individuals are females; that the ovarium exists under the form and situation in which it is described by Cuvier; and that the supposed testis, which makes its appearance in a very questionable form as a glandular tunic of the oviduct, is actually a nidimental gland, and adds an exterior covering to the essential part of the ovum.

But ova are certainly developed in the pulpy substance of the peduncle. These, however, in Cuvier's view of the organs, are supposed to be impregnated ova, conveyed by the extensile tail or ovipositor into the cellular texture of the peduncle. On the diœcious hypothesis, the ova of the peduncle must also be supposed to be conveyed by the ovipositor from the lateral ovaria, but to be impregnated by the males *in transitu*.

The organs of both sexes are, however, combined in the same individual: the part described by Cuvier as the ovarium is the testis; the dilated canal into which its ducts converge is a spermatic receptacle; its glandular walls a prostatic organ; and the terminal flexible and extensile tube the penis. The true ovarium is situated in the peduncle, to the soft tissue of which the ova unquestionably adhere when first developed. It is here that they acquire the azure or violet-coloured yolk; and from this part they subsequently pass into two leaf-shaped receptacles, placed one on each side, between the body of the animal and the lining membrane of the shell. The ova are doubtless impregnated in attaining this situation: here they increase in size, and change their colour to pink and then to white: the embryos are here developed, and, after their escape, all traces of the temporary receptacles disappear.

When we reflect on the uniformity of distribution of the Cirripedes, particular species being attached to particular objects, and these not always stationary and extended bodies, but often living animals, and sometimes animals with quick powers of locomotion; when we further call to mind that they adhere, not by prehensile jaws or feet, but by the growth of a pedunculated root, or by the gradual application of a layer of cement forming the base of their shell, we must be convinced, that the organization and properties of the sedentary Cirripede are wholly inadequate to afford an insight into the process by which it acquired its resting place, and that a knowledge of its previous career from the time of quitting the egg is not less essential to an explanation of the subsequent attachment of the *Cirripedia*, than it was for the elucidation of corresponding phenomena in the *Epizoa*.

No fortuitous dispersion of ova giving origin at once to a pedunculated or sessile multivalve can account for the invariable attachment of the *Coronula* to the skin of the whale, and of the *Otion* to the shell of the parasitic *Coronula*; of the *Chelonobia* to the carapace of the turtle, of the *Cineras* to the tail of the sea-serpent, or of the imbedding of the *Acasta* in the substance of a sponge. These remarkable phenomena have been explicable only since the discovery of the singular metamorphoses which the Cirripedes undergo, and of the power which they possess, at one period of their existence, of attaining and selecting their peculiar and appropriate place of permanent abode. Nor were the real nature and affinities of this singular shell-covered class of animals less problematical and doubtful before the phenomena of their development had been traced out.

Mr. V. Thompson, whose minute and careful researches into the natural history of marine animalcules have thrown much light on the structure and development of radiated animals, was also rewarded by the discovery of the metamorphosis of the Cirripedes. On the 28th April, 1823, he captured, with a small muslin towing net, a number of translucent animalcules, about the tenth of an inch in length, of a sub-elliptic form, slightly compressed, and of a brownish tint; the body of each was defended by a shell composed of two valves, joined by a hinge along the back, and opening along the opposite margin for the protrusion of a large and strong anterior pair of limbs, provided with an adhesive sucker and hooks, and of six pairs of posterior jointed members, terminated by a pencil of bristles. These natatory limbs acted in concert, so as to cause the animal to swim by a succession of bounds like the water fleas (*Daphnia*). The body was terminated by a short tail, composed of two setigerous joints. A pair of pedunculated compound eyes was attached to the anterior and lateral part of the body. Other specimens of this little seeming crustaceous animal were taken on the 1st of May, and preserved alive in a glass vessel of sea-water. On the night of the eighth two of them had thrown off their outer skin, and were firmly adhering to the bottom of the vessel, where they rapidly assumed the form of the young of the sessile Barnacle called *Balanus pusillus*. The sutures between the valves of the shell and of the operculum were visible, and the arms, though not yet perfectly developed, were seen moving within. The eyes also were still perceptible, although the principal part of the black colouring matter appeared to have been thrown off with the exuvium. On the 10th of May another individual was seen in the act of throwing off its exuvium, and attaching itself to the bottom of the glass. As the calcification of the shell proceeds, the eyes gradually disappear, and the visual ray is extinguished for the remainder of the animal's life. The arms at the same time acquire their usual ciliated structure.

The *Lepas*, in its transitory locomotive stage, does not, like the young *Balani*, resemble the bivalve *Ostracoda*, but rather approximates to the genus *Cyclops*. It has a single median sessile eye-speck, three pairs of members, the most anterior of which are simple, the others bifid. The back of the animal is covered, like the *Argulus armiger*, by an ample shield, terminating anteriorly in two extended horns, and posteriorly in a simple elongated spinous process.

The discoveries of Mr. Thompson have been confirmed by Audouin, Wägner, and Burmeister. The latter entomologist divides the development of the Cirripedes into five stages. The first is that of the ovum; the second of the locomotive embryo; the third when the young attaches itself, and becomes encased in a shell; in the fourth stage it gradually assumes the character of the adult; and the fifth stage is that of perfect development.

The locomotive embryo is developed before the ovum quits the parent; the shell, in the first stage of its growth, is coriaceous, and formed of one piece, which is placed on the back. The organs by which the young animal fixes itself are the long antennæ, or setigerous legs, situated near the mouth; in the *Lepas anatifera* the peduncle is formed by a sac-shaped process of the mantle filled with yellowish matter.

The general course of this metamorphosis, and the enjoyment of locomotive and visual organs for a brief period, which are wholly denied to the full-grown animal, characterise a condition which is closely analogous to that of the young in the Epizoa, in the Trematoda, and in the Polypi.

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HUNTERIAN LECTURES

ON THE

GENERATION AND DEVELOPMENT OF THE INVERTEBRATED ANIMALS.

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[*Reported expressly for the Medical Times, and revised by the Lecturer.*]

LECTURE XIII.

GENERATION OF INSECTA.—General characters of the class and of its primary divisions and orders.—All the species diœcious.—Generative system of the Myriapoda.—Vesicular testes and ladder-like anastomoses of the two vasa deferentia in the Iulidæ: advanced position of termination of sperm-ducts.—Male organs of Centipedes.—The single ovarium with single oviducts in Centipedes and the two oviducts in Iulus.—Spermathecæ and colleteria.—Development of embryo.—Hexapod larvæ and their metamorphoses by multiplication of segments and joints.—Affinities and place in the Articulate Series of the Myriapoda deduced from their development and metamorphoses.

MR. PRESIDENT AND GENTLEMEN,—The articulated animals with one pair of jointed antennæ and with jointed limbs, which respire air by stigmata and tracheæ, constitute the vast class of invertebrate animals, called "*Insecta*."

The common or typical number of articulated legs in this class is *six;* disposed in three pairs developed exclusively from the thorax. In the Crustacea we saw that the number was greater, and that the limbs were developed from the abdominal as well as from the thoracic segments of the trunk. Such is the case also with the Myriapodous insects; but these breathe the air directly by means of tracheæ, not by gills, and they have only one pair of antennæ: they likewise manifest, as we shall find, the typical hexapod character in their larval state,—a period during which, as in the Cirripeds, Epizoa, and Acalephæ, the Myriapod shows more of its true nature and is more in accordance with the common type than during its final and oviparous stage.

Taking, however, a survey of the tracheal air-breathing Articulata under their mature condition, they present more important characters in common, than any which indicate an affinity to the gill-bearing classes; and we find them offering the same ground for a primary division as the Crustacea did, viz., in the number of the segments of the body.

This number is constant and definite in the higher and typical members of the group, in which it is neither more nor less than *thirteen:* in the rest it exceeds thirteen, and is variable.

The thirteen-jointed insects have one joint for the head, three for the thorax, and the rest for the abdomen; and, as the thoracic segments alone develope jointed limbs, this primary division or sub-class of Insecta might be called *Hexapoda*.

There is no distinction between thorax and abdomen in the indefinitely-jointed division; and, as all the segments save the first and last support jointed limbs, this sub-class is termed *Myriapoda*. The Myriapoda I regard as a group equivalent to the Entomostraca, and, like them, they are the lowest organized, and the least numerous and varied of the two divisions of their primary group. They are divided according to modifications of the mouth into *Chilognatha* and *Chilopoda*, answering to the genera *Iulus* and *Scolopendra* of Linnæus, who first detected these natural divisions.

The Hexapod insects may be classified,—

1st. According to the phenomena of their development.

2nd. According to the structure of their mouths; or,

3rd. According to the nature of their wings.

Agreeably with the first character, they would be divided into,—

Ametabola, or those that undergo no metamorphosis.

Hemimetabola, or those that undergo a partial metamorphosis; and

Metabola, or those that undergo a complete metamorphosis.

According to the modifications of the Trophi, instrumenta cibaria, or oral organs, the Hexapod insects are divisible, like the myriapods, into two groups, viz., the *Haustellata* or suckers, and the *Mandibulata*, or chewers and biters.

But this binary division is insufficient for the general propositions which the comparative anatomist has to enunciate; and I take, therefore, the third kind of characters, the value of which was first fully discerned by Linnæus, viz., that founded upon the organs of flight. Those Hexapod insects which are devoid of wings are called *Aptera*; those with two wings only, are the *Diptera*. All the rest have four wings. The *Lepidoptera* have four scaly wings; the *Hymenoptera* have four veined wings, crossing each other when at rest; the *Hemiptera* have one pair of wings partially thickened, and called hemelytra; the *Orthoptera* have one pair of wings wholly thickened, the other folded lengthwise; the *Coleoptera* have one pair wholly and much thickened, called elytra, and the other pair folded cross-wise; the *Neuroptera* have four reticulated wings; the *Strepsiptera* have one pair of wings rudimental and curled up. In the *Aphaniptera* both pairs are rudimental and functionless as wings. Of these orders, the first five are "haustellate;" the remaining four are "mandibulate." The Aptera are ametabolian; the Hemiptera and Orrhoptera are hemimetabolian; the remaining orders are "metabolian." These characters, therefore, briefly and succinctly express the highest generalizations, as yet reached, relative to the Hexapod Insecta.

I have said, that the Hexapods have thirteenth segments; but, in the last stage of the metabolian orders, one, two, or three segments may become blended together; and again, although we reckon the head as a single segment, the number of jointed appendages which it supports, under the name of antennæ, mandibulæ, maxillæ, palpi, &c., indicates that here, as in the Crustacea, it consists essentially of several coalesced segments.

With regard to the orders of the Myriapoda I may remark, that the *Chilognatha* have two biarticulate mandibles, without palpi, armed with imbricated teeth planted in a cavity at the upper extremity of the mandible; they have also a kind of lip situated immediately beneath, and covering the mandibles, notched into four divisions, and answering to the two pairs of maxillæ of the Crustacea; whence the name from the Greek, signifying, "feeding by jaws." The Iulus, or Gally-worm, is a type of this order. The *Chilopoda* have the mouth composed of two mandibles, with a small palp,; a quadrifid lip, also the homologue of the crustaceous maxillæ confluent; two labial palpi, hooked at the tip; and a second pair of jaws, or foot-jaws—the obvious homotypes of feet—terminated by a strong hook, moveable, and pierced beneath the extremity by a poison-duct. The Centipede (*Scolopendra*) is the type of this order of Myriapods, which "feed by feet."

All Insecta are diœcious. In most the sexes are distinguished by external characters; these, however, are least conspicuous in the Myriapoda; but the external outlets of the generative organs of the male are, in the Chilognatha, as in many Crustacea, situated on a segment posterior to that

which is perforated by the generative organs in the female.

In the male Gally-worm (*Iulus terrestris*), the testis consists of minute cœca appended, for the most part alternately, to the sides of a long efferent tube: there are two of these on each side, which, commencing in the posterior fourth of the body, advance forwards, and unite on each side so as to form a pair of tubes; the cœcal glands continue to be developed, but in smaller number, and from one side principally of each of the common tubes. These tubes then approximate, communicate together by three or more transverse canals, and, after a slight bend or convolution, extend straight forward to the sternal arc of the seventh segment of the trunk, where they terminate by distinct orifices behind the seventh pair of legs.

The structure of the spermatic cœca is so similar to that of the longitudinal tubes, that the secerning function is doubtless exercised by both parts; they consist of a thick mucous coat, with an external muscular tunic; they are situated beneath, or ventrad of, the alimentary canal, and between the two large salivary vessels. In the Crustacea the testes are dorsad of the alimentary canal, and their ducts external to the glandular appendages of that canal.

The transverse anastomosing canals, between the right and left testes, reminds one of the single transverse communication between the two testes in the lobster and in the crawfish; but this character is so multiplied—Mr. Newport having found more than twenty such transverse canals in one species of Iulus—that the testes offer no unapt resemblance to a ladder. In a large species the same laborious and eminent entomotomist discovered that the semicorneous intromittent organ was defended by an uncinated valve, serving as a holder or clasper.

The contents of the testes are a clear fluid at the hinder beginning of the organs, but it becomes thick and more opaque as the outlets are approached. The change is due to the appearance of numerous sperm cells, 1-450th of a line in diameter, with a highly refracting nucleus 1-750th of a line in diameter, lying close to the cell-wall. In the progress of development the nucleus enlarges and becomes conical, the apex protruding from the surface of the cell, which finally dissolves and leaves the nucleus free. This is the spermatozoon: its breadth always exceeds its height or length.

In the *Iulus fabulosus* the cell-wall becomes enlarged at the part opposite to the nucleus, and produces there a similar nuclear body: the whole thus appears like two of the spermatozoa of the *Iulus terrestris*, with their broad bases turned towards and touching each other.

For these observations on the development and singular form of the spermatozoa of the Chilognatha, we are indebted chiefly to the labours of Siebold and Wagner.

In the *Chilopoda* the generative organs terminate at the anal segment of the body, not, as in the Chilognatha, near the fore part of the body.

In the Scolopendra the male organs are more complex, and resemble those of insects. The testes of the *Scolopendra morsitans* are seven in number, and closely packed in parallel lines; each testis is composed of two parts, fusiform and precisely similar to each other in mutual contact, but easily separable. From each extremity of the fusiform testis arises a narrow duct, so that there are fourteen pairs of ducts arising from the fourteen secreting organs. Each of the testicular bodies is hollow internally. The ducts ultimately end in a common tube which soon becomes enlarged and tortuous, terminating by a simple aperture near the anus. Just prior to its termination, the enlarged canal receives five accessory glands, four of which are intimately united, until unravelled, while the fifth is a simple cœcum of considerable length. The sexual outlet is situate near the anus.

There is very great diversity in the structure of the male organs in the different genera of Myriapoda.

In the *Scutigera*, according to Léon Dufour, the testes are two fusiform organs, with a duct continued from each extremity; those from the upper end anastomose together, and a long and slender canal is continued from the middle of the arch, which, after a certain course, becomes disposed in a series of progressively increasing transverse folds, and finally divides into two terminal slender pyriform sacs. These Léon Dufour regards as accessory vesicles. The sperm-ducts continued from the lower ends of the fusiform testes bend upward upon themselves, and dilate into reservoirs called "spermathecæ," similar in size and shape to the testes themselves, and each of these terminate separately upon the anal segment.

The fusiform testes have many small pouches or diverticula produced from their outer side. In the genus *Lithobius* the testes are fusiform, but free at their upper pointed ends, and they are everywhere beset with numerous subspherical or graniform secerning follicles. Three long blind tubes—accessory glands—communicate with the proper sperm-ducts; the common opening being, as in other Chilopoda, at the terminal segment. Treviranus speaks of a small fleshy corneous penis in the Lithobius.

With regard to the female organs of the Myriapoda. In the *Iulus terrestris*, the ovarium is a simple elongated sac, with the exterior surface nodulated by sacculi; the larger ones, of uniform size, being arranged in a double series. The ova are developed and completed in these sacculi, one in each; the germinal vesicle here is surrounded by the yolk and vitelline membrane; upon this is laid the thin layer of albumen and the corion before it passes into the common oviduct. The ova in the earlier phase of development form small projections at the interspaces of the larger and more regularly-sized ovisacs containing the more mature ova. The common elongated sac extends from the anal segment forward to near the fourth segment, where it divides, and the two vulvæ are situated on that segment behind the second pair of legs. The ovarian tube is situated beneath the alimentary canal; not above it, as in the Crustacea. If the male apertures on the seventh segment indicate, by the analogy of the Crustacea, the hinder boundaries of the thorax, we see that the more advanced position of the female apertures keeps up that analogy. Another interesting analogy presents itself in the double aperture of the generative outlets and the double intromittent or clasping organs in the male *Iulidæ*. I allude to the serpent tribe, which these Articulata resemble in their length, and slenderness, and tortuous movements; for the serpents alone, amongst vertebrata, present the double termination of the generative ducts and the double unciform claspers.

In the *Lithobius forficatus*, the ovarium, a single elongated blind sac, extends from the anal segment to near the middle of the body, and is supported by the tracheal capillaries. It is beset by numerous subpedunculate unilocular bursæ, each containing a white globular ovum. These give a granular aspect to the exterior of the ovarian tube: which tube, Léon-Dufour suspects to be naturally divided by a median longitudinal septum.

On each side of the termination of the ovarian tube is a racemose colleterium, consisting each of two rows of granular utricules: a common duct and reservoir communicates with the oviduct.

On the interesting subject of the development of the Myriapoda, some important facts were early recorded relative to the metamorphoses of the Iulidæ by Degeer and Savi; and their generation has been very ably and minutely worked out by Mr. Newport, whose valuable memoir on the subject has been published in the Philosophical Transactions for the year 1841.

The *Iulus terrestris* hibernates from October to March; the female is probably impregnated prior to hybernation, for her first act, after awakening from the long winter-sleep, is to prepare to disembarrass herself of the load of impregnated ova; the act of oviposition is generally over by the month of May. She previously excavates a special nidamental cavity in the soil, and is careful to place the eggs where no access of light, and only a certain degree of moisture, can affect them. In this process she bores the soil about an inch in depth, just wide enough to admit her own body, and then excavates a circular cavity by removing the soil, pellet by pellet, the earth being made up into a little pill by mixture with her saliva; she withdraws herself backwards from her hole, bringing up the pellet, which is held between her bent-down head and the first pair of legs: it is then passed backwards to the second pair, which transfers it to the next in succession, and so onwards, until it is removed quite out of the way. When, by the repetition of this manœuvre, the egg-chamber is completed, oviposition takes place, and the entry to the chamber is carefully closed by earth thoroughly moistened, so as to form a thick paste, which she gently presses into the entrance, and fills up nearly to a level with the surface of the soil. Thus protecting the eggs from enemies that would devour them, or from the atmosphere and light which might decompose them. In this operation we may perceive that the large salivary glands have a function analogous to that of the silk glands of the *Bombyx mori*.

In the fresh-laid egg the chorion is transparent, but it soon becomes opaque, soon dries and shrivels when exposed to the air. The first period of development occupies about twenty-five days, when the chorion is ruptured, the egg previously augmenting in size and becoming reniform. The embryo may be recognised about the twelfth day, but presents no trace of segments or limbs; it is bent upon itself. On the thirteenth or fourteenth day there is an indication of segments on the ventral aspect. On the eighteenth day the shell bursts along the dorsal surface, and on the twenty-fifth day the embryo protrudes, by the elastic quality of its body overcoming the compression to which its growth has subjected it; but the embryo is passive and motionless, and is still connected by a reflection of an amniotic covering upon the inner surface of the membrana vitelli, which connexion Mr. Newport calls the "umbilicus." There is now a head and seven segments, and the antennæ may be seen budding from the sides of the head. The internal structure of the embryo is wholly cellular, with a cavity resulting from the coalescence and liquefaction of certain central cells. On the third day after exclusion the embryo is passive, motionless, and still attached to the shell by the funis-like duplicature of the amniotic covering, and it is protected by the two halves of the egg-shell, suggestive of an analogy to the entomostracous *Cypris*. The head, antennæ, and segments of the body are better marked; but the embryo is still apodal, though rudiments, or buds of thoracic limbs, now begin to be discernible. Some of the peripheral cells become pushed into these buds of limbs, making them obtuse prior to elongation. On the ninth day the funis is ruptured, and the alimentary canal completed; but other internal parts consist of cells of different sizes. On the tenth day the dorsal vessel betrays itself by its pulsations; it drives the colourless blood to the head, which now becomes corneous; the antennæ become clubbed, and now a simple ocellus may be distinctly seen on each side. On the seventeenth day the embryo leaves the debris of its shell: it presents definite segments, articulated antonnæ, and three pairs of jointed legs; it is, in short, a hexapod larva. But by the next stage of progress it quits the high road of insect development to enter a bye-path of its own. New segments are formed from the penultimate or germinal segment; a remnant of the funis is converted into a rudimental anal spine. The amniotic covering and the rest of the funis are moulted.

The first spontaneous movements of the embryo are to burst and slip off the amnion, with the first integument, after which exertion the larva reposes, with slight occasional movements of the antennæ. We may now distinguish a prothorax, with eight other primary segments; six new segments have also been formed at the germinal space, but these are short, and collectively are only equal to one of the original segments. The new segments are not formed by a division of the old, but by gemmation from the penultimate segment at the germinal space. The primary three pairs of legs are developed from the second, third, and fifth primary segments. New pairs of limbs bud out from the sixth and seventh

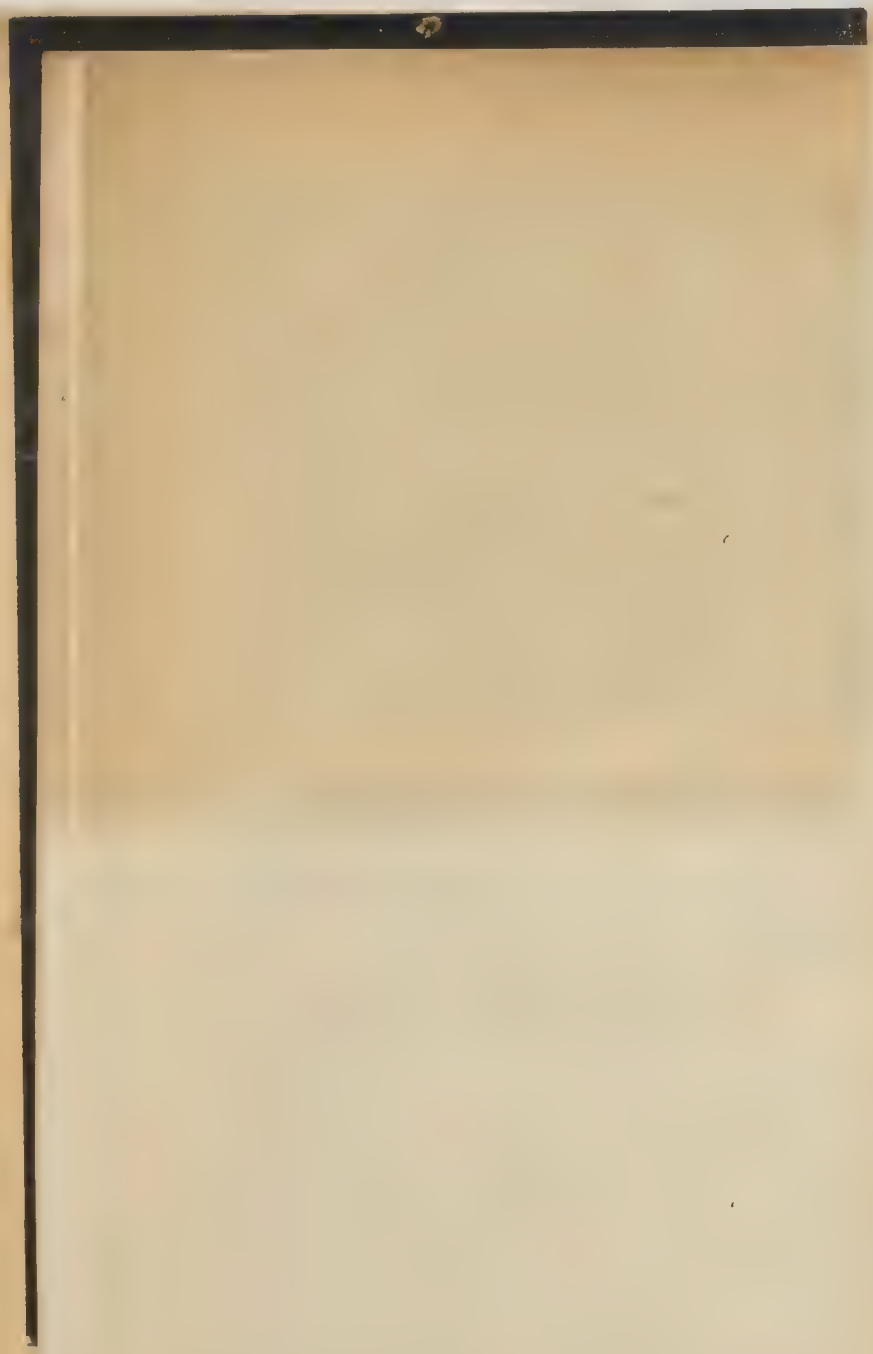
segments. The female apertures are perforated in the fourth segment; the male outlet is established at the seventh segment, when this is near the posterior end of the body of the larva.

The antennæ first begin to move, then the legs, and the first instinct of the locomotive larva is to shun the light. In this progression the anal segment is first expanded, and attaches itself to the firm surface; then the body is carried forwards, the motion being propagated from segment to segment. In the progress of growth these are successively added at the germinal space; the new segments being always produced beneath the common integument, which is afterwards moulted. These segments are added in a certain numerical ratio, six at a time, between the antepenultimate and the penultimate segments. Movements of the larva are always observed to be fettered by the approach of the ecdysis. All the limbs superadded to the primary three pairs are bifid; and these double legs are analogous to the prolegs of caterpillars. The further course of growth is attended with a more distinct definition of the segments; and by transverse indents of the primary segments. The limbs also become more straightened. The whole period of development occupies four or five weeks, and then development is superseded by the mere actof growth.

With regard to the Centipedes, we still need a series of researches to make us properly acquainted with their development. A French naturalist has recorded a series of researches on the genus Lithobius. This is a modified centipede, consisting of seventeen segments, and having fifteen pairs of extremities. In the month of May, the larva presents but ten joints and seven pairs of legs with two simple ocelli on each side of the head. Early in June, it had acquired twelve segments, and eight pairs of legs, and the head presented three ocelli on each side. Later on in the same month, the segments had increased to fifteen, and the legs to fifteen pairs, and the number of ocelli was eight; finally, two more segments were added, and the cluster of ocelli included twenty on each side. The chief distinction between the Lithobius and Iulus appears to be, that the successive joints are not developed, as in the Iulidæ, at the posterior part of the body, from one particular germinal space, but at the interspaces of the pre-existing segments.

With regard to the affinities of the Myriapoda as they are illustrated by the known phenomena of their development, we discover in the peculiarly localised power of superadding the additional joints in the Iulidæ, a marked analogy to the annellides; yet the appendages of the segments being distinctly jointed limbs, we have in these a well-marked character of the superiority of the Chilognatha. Then, in reference to the Crustacea, which the Myriapoda more resemble in their jointed antennæ and limbs, we perceive also an interesting additional analogy in the Chilognatha, in the circumstance of the organs of the generative apparatus not terminating in the homologous segments in the male and in the female; whilst in both they are situated nearer the anterior part of the body. But this crustaceous character disappears in the Chilopoda. And when we perceive that the first form of the articulated animal with jointed limbs, which the Myriapoda assume, is that of the hexapod insect, and further, that in departing from this type, the pair of limbs successively added in the Iulus are like those temporary ones in the caterpillars, of a different character from the primary six,—we cannot but derive from these facts a well-founded confidence in the importance of that character of the respiratory system which led us, at the beginning, to class the Myriapoda with the Insecta rather than the Crustacea.

William Tyler, Printer, Bolt-court, London.



Sheen Lodge, Richmond Park, East Sheen,
11th June, 1887.

Dear Woodward,

Can you make a half-holiday on Tuesday 14th. and escort Mrs. Woodward, Miss W. (my friendly Artiste) and your Son, to dine here, at 6 p.m.; but coming early in walking attire, for Park & Garden?

Oblige,

Yours ever truly,

Richard Owen.

Sheen Lodge
Richmond Park.
6th June, 1888.

Dear Woodward,

Thanks for your welcome Note of the 5th, inclosing the Artiste's card.

All your W. W.s, now the Home, will be gladly welcomed to the 6 o'clock dinner any day, - especially a fine one - after receipt of this. I may ask for a postcard for your date, lest I should be whisked off to the White Lodge in a Royal Carriage. The show of colours in the Garden is now fine! Come early, to your's ever truly,

Richard Owen

Sheen Lodge
Richmond Park.
13th March, 1888.

Dear Woodward,

Thanks for your friendly Note inclosing the pencil-outlines of surface characters of parts of the Ammonite.

My 'keeping the fire-side' has been a preventive measure:- the chronic cough I have had so long I should now be - I think - sorry to part with; but it neither troubles rest or appetite: failure of general strength warns me that I may soon follow my estimable Fellow-worker worthy Waterhouse!

Ever truly your's, &
with kind regards & best wishes to the Circle,

Richard Owen.

Sheen Lodge, Richmond Park, East Sheen,
11th. June, 1887.

Dear Woodward,

Can you make a half-holiday on Tuesday 14th. and escort Mrs. Woodward, Miss W. (my friendly Artiste) and your Son, to dine here, at 6 p.m.; but coming early in Walking attire, for Park & Garden!

Sincerely

I am grateful for your attention to my petition about [illegible]

MONDAY, DECEMBER 19, 1892.

Sir Richard Owen passed away peacefully at three o'clock yesterday morning at his residence, Sheen Lodge, Richmond Park, Surrey. He was in his eighty-ninth year.

RICHARD OWEN has cast aside the burden of eight-and-eighty years of life with unblemished honour, and with renown which it is not too much to say is coextensive with civilisation. He was one of the few transcendental anatomists who could claim the great monarchs of science as their peers—who could justly demand that his name should be inscribed on the Roll of Honour wherein VESALIUS, the almost forgotten Englishman HEWSON, HUNTER, CUVIER, GOODSIR, and RUDOLPH VON VIRCHOW (still happily preserved to us), and perhaps ALLEN THOMPSON, had a right to "blazon the scroll of fame." No offence need be taken by more celebrated anatomists at this appreciation of OWEN'S powers, for it is the note of the modern, may we say the middle-class, anatomy of the middling Victorian period—so brilliantly represented by the Right Honourable Professor HUXLEY, P.C.—to have eliminated what they called transcendentalism, but what the others called the spirit which is life, from this study of life in death. Perhaps the men of the middling class were right—who shall say that they were not? Materialism and "modernity" have brought them success. The old Transcendentalists are not now in the stream of things, and OWEN was among the last of them. Younger men who devoted their redundant energies alternately to attacks on his work and on every element of life that makes for progress and righteousness, have climbed thereby into pomp, place, and power. They need not then grudge a passing tribute to his fading memory. Mr. HENRY ARTHUR JONES thinks that the bane of dramatic art in England is "the smart young man in the billycock-hat." But his "homologue," as Professor HUXLEY would say, exists in the scientific world, and it was his mission to extinguish the Transcendental school of anatomy of which OWEN was the most illustrious representative in the Victorian age. This mission, we admit, he carried to absolute and complete success, so that it will be perhaps better for our peace of mind to say without reserve that in OWEN'S highest work—*e.g.*, where he reduced all vertebrate structure to a single type figured in one of the bones of a human spine, from which he showed all other foundations of vertebrate structure, including the most complex of brain-pans, could be built up by infinite but possible modification—there was an element of phantasy—nay, poetry, if you will—which was out of sorts with the realistic temper of the gross times through which we have been passing. His work was in truth an irrepressible tribute to the usefulness of the imagination in science; and in another column we present a record of it in detail. The great master of Greek tragedy "saw life, and saw it whole." That was how OWEN and the Transcendentalists viewed the architecture of the animal body; and though he was ultimately silenced by Materialism—blatant in popular lectures and showy research—it is, we fear, a little hazardous even yet to say dogmatically that his teaching and his doctrines will be for ever buried in the kindly dust that covers the work that perishes. There be strange and bodeful rumours afloat that daring and graceless young men on the Continent are beginning to question whether the Right Honourable Mr. HUXLEY has really spoken the last word proving the identity of the bit of brain in the ape and man that we are taught establishes their painfully close kinship. Venturesome youths, who are even bold—or as Mrs. GAMP would have said, "brajian"—enough to suggest that embryology is coming to yield results not at all incompatible with what we have been taught to regard as OWEN'S fanciful theories, and that a time will perhaps come when the influence of the great school he represented with all the grandeur of conception and breadth of view of men who did not let the prolonged use of the microscope blind their eyes to the significance of the larger forms of animal structure, will again reassert itself in science. Of his practical work, alike as a museum curator and administrator in the scientific service of the State, it were impossible to speak too highly. He had even toiled in his day as a drudging practitioner of medicine among the poor. One of his first great scientific achievements was a surgical memoir discussing the practical question whether it was possible by means of the knife to get at the deep iliac artery and tie it, so as to cure a fatal form of aneurism. Had his successor only been sensible enough to follow his practical planning of the new Natural History Museum at Kensington, that establishment would have possessed a lecture-room in which it would have been possible to address a moderately-sized audience without the risk of asphyxiating them. Personally, RICHARD OWEN was a charming old gentleman—adored by his pupils and his subordinates, and never happier than when assisting others, and bestowing on those in whom he discerned a nature not entirely sordid or destitute of reverence for the poetry and mystery of life, the sweetest and most helpful courtesies.

HUNTERIAN LECTURES

ON THE

GENERATION AND DEVELOPMENT OF THE INVERTEBRATED ANIMALS.

By RICHARD OWEN, F.R.S.

HUNTERIAN PROFESSOR AND CURATOR OF MUSEUM OF ROYAL COLLEGE OF SURGEONS, CORRESPONDING MEMBER OF THE INSTITUTE OF FRANCE, &c.

[*Reported expressly for the Medical Times, and revised by the Lecturer.*]

LECTURE XII.

GENERATION OF INSECTA.—General characters of the class and of its primary divisions and orders.—All the species dioecious.—Generative system of the Myriapoda.—Vesicular testes and ladder-like anastomoses of the two vasa deferentia in the Iulidæ: advanced position of termination of sperm-ducts.—Male organs of Centipedes.—The single ovarium with single oviducts in Centipedes and the two oviducts in Iulus.—Spermathecæ and colleteria.—Development of embryo.—Hexapod larvæ and their metamorphoses by multiplication of segments and joints.—Affinities and place in the Articulate Series of the Myriapoda deduced from their development and metamorphoses.

MR. PRESIDENT AND GENTLEMEN,—The articulated animals with one pair of jointed antennæ and with jointed limbs, which respire air by stigmata and tracheæ, constitute the vast class of invertebrate animals, called "*Insecta.*"

The common or typical number of articulated legs in this class is *six;* disposed in three pairs developed exclusively from the thorax. In the Crustacea we saw that the number was greater, and that the limbs were developed from the abdominal as well as from the thoracic segments of the trunk. Such is the case also with the Myriapodous insects; but these breathe the air directly by means of tracheæ, not by gills, and they have only one pair of antennæ: they likewise manifest, as we shall find, the typical hexapod character in their larval state,—a period during which, as in the Cirripeds, Epizoa, and Acalephæ, the Myriapod shows more of its true nature and is more in accordance with the common type than during its final and oviparous stage.

Taking, however, a survey of the tracheal air-breathing Articulata under their mature condition, they present more important characters in common, than any which indicate an affinity to the gill-bearing classes; and we find them offering the same ground for a primary division as the Crustacea did, viz., in the number of the segments of the body.

This number is constant and definite in the higher and typical members of the group, in which it is neither more nor less than *thirteen:* in the rest it exceeds thirteen, and is variable.

The thirteen-jointed insects have one joint for the head, three for the thorax, and the rest for the abdomen; and, as the thoracic segments alone develope jointed limbs, this primary division or sub-class of Insecta might be called *Hexapoda.*

There is no distinction between thorax and abdomen in the indefinitely-jointed division; and, as all the segments save the first and last support jointed limbs, this sub-class is termed *Myriapoda.* The Myriapoda I regard as a group equivalent to the Entomostraca, and, like them, they are the lowest organized, and the least numerous and varied of the two divisions of their primary group. They are divided according to modifications of the mouth into *Chilognatha* and *Chilopoda*, answering to the genera *Iulus* and *Scolopendra* of Linnæus, who first detected these natural divisions.

The Hexapod insects may be classified,—

1st. According to the phenomena of their development.

2nd. According to the structure of their mouths; or,

3rd. According to the nature of their wings.

Agreeably with the first character, they would be divided into,—

Ametabola, or those that undergo no metamorphosis.

Hemimetabola, or those that undergo a partial metamorphosis; and

Metabola, or those that undergo a complete metamorphosis.

According to the modifications of the Trophi, instrumenta cibaria, or oral organs, the Hexapod insects are divisible, like the myriapods, into two groups, viz., the *Haustellata* or suckers, and the *Mandibulata*, or chewers and biters.

But this binary division is insufficient for the general propositions which the comparative anatomist has to enunciate; and I take, therefore, the third kind of characters, the value of which was first fully discerned by Linnæus, viz., that founded upon the organs of flight. Those Hexapod insects which are devoid of wings are called *Aptera*; those with two wings only, are the *Diptera*. All the rest have four wings. The *Lepidoptera* have four scaly wings; the *Hymenoptera* have four veined wings, crossing each other when at rest; the *Hemiptera* have one pair of wings partially thickened, and called hemelytra; the *Orthoptera* have one pair of wings wholly thickened, the other folded lengthwise; the *Coleoptera* have one pair wholly and much thickened, called elytra, and the other pair folded cross-wise; the *Neuroptera* have four reticulated wings; the *Strepsiptera* have one pair of wings rudimental and curled up. In the *Aphaniptera* both pairs are rudimental and functionless as wings. Of these orders, the first five are "haustellate;" the remaining four are "mandibulate." The Aptera are ametabolian; the Hemiptera and Orrhoptera are hemimetabolian; the remaining orders are "metabolian." These characters, therefore, briefly and succinctly express the highest generalizations, as yet reached, relative to the Hexapod Insecta.

I have said, that the Hexapods have thirteenth segments; but, in the last stage of the metabolian orders, one, two, or three segments may become blended together; and again, although we reckon the head as a single segment, the number of jointed appendages which it supports, under the name of antennæ, mandibulæ, maxillæ, palpi, &c., indicates that here, as in the Crustacea, it consists essentially of several coalesced segments.

With regard to the orders of the Myriapoda I may remark, that the *Chilognatha* have two biarticulate mandibles, without palpi, armed with imbricated teeth planted in a cavity at the upper extremity of the mandible; they have also a kind of lip situated immediately beneath, and covering the mandibles, notched into four divisions, and answering to the two pairs of maxillæ of the Crustacea; whence the name from the Greek, signifying, "feeding by jaws." The Iulus, or Gally-worm, is a type of this order. The *Chilopoda* have the mouth composed of two mandibles, with a small palp,; a quadrifid lip, also the homologue of the crustaceous maxillæ confluent; two labial palpi, hooked at the tip; and a second pair of jaws, or foot jaws—the obvious homotypes of feet—terminated by a strong hook, moveable, and pierced beneath the extremity by a poison-duct. The Centipede (*Scolopendra*) is the type of this order of Myriapods, which "feed by feet."

All Insecta are dioecious. In most the sexes are distinguished by external characters; these, however, are least conspicuous in the Myriapoda; but the external outlets of the generative organs of the male are, in the Chilognatha, as in many Crustacea, situated on a segment posterior to that

which is perforated by the generative organs in the female.

In the male Gally-worm (*Iulus terrestris*), the testis consists of minute cœca appended, for the most part alternately, to the sides of a long efferent tube: there are two of these on each side, which, commencing in the posterior fourth of the body, advance forwards, and unite on each side so as to form a pair of tubes; the cœcal glands continue to be developed, but in smaller number, and from one side principally of each of the common tubes. These tubes then approximate, communicate together by three or more transverse canals, and, after a slight bend or convolution, extend straight forward to the sternal arc of the seventh segment of the trunk, where they terminate by distinct orifices behind the seventh pair of legs.

The structure of the spermatic cœca is so similar to that of the longitudinal tubes, that the secerning function is doubtless exercised by both parts; they consist of a thick mucous coat, with an external muscular tunic; they are situated beneath, or ventrad of, the alimentary canal, and between the two large salivary vessels. In the Crustacea the testes are dorsad of the alimentary canal, and their ducts external to the glandular appendages of that canal.

The transverse anastomosing canals, between the right and left testes, reminds one of the single transverse communication between the two testes in the lobster and in the crawfish; but this character is so multiplied—Mr. Newport having found more than twenty such transverse canals in one species of Iulus—that the testes offer no unapt resemblance to a ladder. In a large species the same laborious and eminent entomotomist discovered that the semicorneous intromittent organ was defended by an uncinated valve, serving as a holder or clasper

The contents of the testes are a clear fluid at the hinder beginning of the organs, but it becomes thick and more opaque as the outlets are approached. The change is due to the appearance of numerous sperm cells, 1-450th of a line in diameter, with a highly refracting nucleus 1-750th of a line in diameter, lying close to the cell-wall. In the progress of development the nucleus enlarges and becomes conical, the apex protruding from the surface of the cell, which finally dissolves and leaves the nucleus free. This is the spermatozoon: its breadth always exceeds its height or length.

In the *Iulus fabulosus* the cell-wall becomes enlarged at the part opposite to the nucleus, and produces there a similar nuclear body: the whole thus appears like two of the spermatozoa of the *Iulus terrestris*, with their broad bases turned towards and touching each other.

For these observations on the development and singular form of the spermatozoa of the Chilognatha, we are indebted chiefly to the labours of Siebold and Wagner.

In the *Chilopoda* the generative organs terminate at the anal segment of the body, not, as in the Chilognatha, near the fore part of the body.

In the Scolopendra the male organs are more complex, and resemble those of insects. The testes of the *Scolopendra morsitans* are seven in number, and closely packed in parallel lines; each testis is composed of two parts, fusiform and precisely similar to each other in mutual contact, but easily separable. From each extremity of the fusiform testis arises a narrow duct, so that there are fourteen pairs of ducts arising from the fourteen secreting organs. Each of the testicular bodies is hollow internally. The ducts ultimately end in a common tube which soon becomes enlarged and tortuous, terminating by a simple aperture near the anus. Just prior to its termination, the enlarged canal receives five accessory glands, four of which are intimately united, until unravelled, while the fifth is a simple cœcum of considerable length. The sexual outlet is situate near the anus.

There is very great diversity in the structure of the male organs in the different genera of Myriapoda.

In the *Scutigera*, according to Léon Dufour, the testes are two fusiform organs, with a duct continued from each extremity; those from the upper end anastomose together, and a long and slender canal is continued from the middle of the arch, which, after a certain course, becomes disposed in a series of progressively increasing transverse folds, and finally divides into two terminal slender pyriform sacs. These Léon Dufour regards as accessory vesicles. The sperm-ducts continued from the lower ends of the fusiform testes bend upward upon themselves, and dilate into reservoirs called "spermathecæ," similar in size and shape to the testes themselves, and each of these terminate separately upon the anal segment.

The fusiform testes have many small pouches or diverticula produced from their outer side. In the genus *Lithobius* the testes are fusiform, but free at their upper pointed ends, and they are everywhere beset with numerous subspherical or graniform secerning follicles. Three long blind tubes—accessory glands—communicate with the proper sperm-ducts; the common opening being, as in other Chilopoda, at the terminal segment. Treviranus speaks of a small fleshy corneous penis in the Lithobius.

With regard to the female organs of the Myriapoda. In the *Iulus terrestris*, the ovarium is a simple elongated sac, with the exterior surface nodulated by sacculi; the larger ones, of uniform size, being arranged in a double series. The ova are developed and completed in these sacculi, one in each; the germinal vesicle here is surrounded by the yolk and vitelline membrane; upon this is laid the thin layer of albumen and the corion before it passes into the common oviduct. The ova in the earlier phase of development form small projections at the interspaces of the larger and more regularly-sized ovisacs containing the more mature ova. The common elongated sac extends from the anal segment forward to near the fourth segment, where it divides, and the two vulvæ are situated on that segment behind the second pair of legs. The ovarian tube is situated beneath the alimentary canal; not above it, as in the Crustacea. If the male apertures on the seventh segment indicate, by the analogy of the Crustacea, the hinder boundaries of the thorax, we see that the more advanced position of the female apertures keeps up that analogy. Another interesting analogy presents itself in the double aperture of the generative outlets and the double intromittent or clasping organs in the male *Iulidæ*. I allude to the serpent tribe, which these Articulata resemble in their length, and slenderness, and tortuous movements; for the serpents alone, amongst vertebrata, present the double termination of the generative ducts and the double uniform claspers.

In the *Lithobius forficatus*, the ovarium, a single elongated blind sac, extends from the anal segment to near the middle of the body, and is supported by the tracheal capillaries. It is beset by numerous subpedunculate unilocular bursæ, each containing a white globular ovum. These give a granular aspect to the exterior of the ovarian tube: which tube, Léon-Dufour suspects to be naturally divided by a median longitudinal septum.

On each side of the termination of the ovarian tube is a racemose colleterium, consisting each of two rows of granular utricules: a common duct and reservoir communicates with the oviduct.

On the interesting subject of the development of the Myriapoda, some important facts were early recorded relative to the metamorphoses of the Iulidæ by Degeer and Savi; and their generation has been very ably and minutely worked out by Mr. Newport, whose valuable memoir on the subject has been published in the Philosophical Transactions for the year 1841.

The *Iulus terrestris* hibernates from October to March; the female is probably impregnated prior to hybernation, for her first act, after awakening from the long winter-sleep, is to prepare to disembarrass herself of the load of impregnated ova; the act of oviposition is generally over by the month of May. She previously excavates a special nidamental cavity in the soil, and is careful to place the eggs where no access of light, and only a certain degree of moisture, can affect them. In this process she bores the soil about an inch in depth, just wide enough to admit her own body, and then excavates a circular cavity by removing the soil, pellet by pellet, the earth being made up into a little pill by mixture with her saliva; she withdraws herself backwards from her hole, bringing up the pellet, which is held between her bent-down head and the first pair of legs: it is then passed backwards to the second pair, which transfers it to the next in succession, and so onwards, until it is removed quite out of the way. When, by the repetition of this manœuvre, the egg-chamber is completed, oviposition takes place, and the entry to the chamber is carefully closed by earth thoroughly moistened, so as to form a thick paste, which she gently presses into the entrance, and fills up nearly to a level with the surface of the soil. Thus protecting the eggs from enemies that would devour them, or from the atmosphere and light which might decompose them. In this operation we may perceive that the large salivary glands have a function analogous to that of the silk glands of the *Bombyx mori*.

In the fresh-laid egg the chorion is transparent, but it soon becomes opaque, soon dries and shrivels when exposed to the air. The first period of development occupies about twenty-five days, when the chorion is ruptured, the egg previously augmenting in size and becoming reniform. The embryo may be recognised about the twelfth day, but presents no trace of segments or limbs; it is bent upon itself. On the thirteenth or fourteenth day there is an indication of segments on the ventral aspect. On the eighteenth day the shell bursts along the dorsal surface, and on the twenty-fifth day the embryo protrudes, by the elastic quality of its body overcoming the compression to which its growth has subjected it; but the embryo is passive and motionless, and is still connected by a reflection of an amniotic covering upon the inner surface of the membrana vitelli, which connexion Mr. Newport calls the "umbilicus." There is now a head and seven segments, and the antennæ may be seen budding from the sides of the head. The internal structure of the embryo is wholly cellular, with a cavity resulting from the coalescence and liquefaction of certain central cells. On the third day after exclusion the embryo is passive, motionless, and still attached to the shell by the funis-like duplicature of the amniotic covering, and it is protected by the two halves of the egg-shell, suggestive of an analogy to the entomostracous *Cypris*. The head, antennæ, and segments of the body are better marked; but the embryo is still apodal, though rudiments, or buds of thoracic limbs, now begin to be discernible. Some of the peripheral cells become pushed into these buds of limbs, making them obtuse prior to elongation. On the ninth day the funis is ruptured, and the alimentary canal completed; but other internal parts consist of cells of different sizes. On the tenth day the dorsal vessel betrays itself by its pulsations; it drives the colourless blood to the head, which now becomes corneous; the antennæ become clubbed, and now a simple ocellus may be distinctly seen on each side. On the seventeenth day the embryo leaves the debris of its shell: it presents definite segments, articulated antonnæ, and three pairs of jointed legs; it is, in short, a hexapod larva. But by the next stage of progress it quits the high road of insect development to enter a bye-path of its own. New segments are formed from the penultimate or germinal segment; a remnant of the funis is converted into a rudimental anal spine. The amniotic covering and the rest of the funis are moulted.

The first spontaneous movements of the embryo are to burst and slip off the amnion, with the first integument, after which exertion the larva reposes, with slight occasional movements of the antennæ. We may now distinguish a prothorax, with eight other primary segments; six new segments have also been formed at the germinal space, but these are short, and collectively are only equal to one of the original segments. The new segments are not formed by a division of the old, but by gemmation from the penultimate segment at the germinal space. The primary three pairs of legs are developed from the second, third, and fifth primary segments. New pairs of limbs bud out from the sixth and seventh

segments. The female apertures are perforated in the fourth segment; the male outlet is established at the seventh segment, when this is near the posterior end of the body of the larva.

The antennæ first begin to move, then the legs, and the first instinct of the locomotive larva is to shun the light. In this progression the anal segment is first expanded, and attaches itself to the firm surface; then the body is carried forwards, the motion being propagated from segment to segment. In the progress of growth these are successively added at the germinal space; the new segments being always produced beneath the common integument, which is afterwards moulted. These segments are added in a certain numerical ratio, six at a time, between the antepenultimate and the penultimate segments. Movements of the larva are always observed to be fettered by the approach of the ecdysis. All the limbs superadded to the primary three pairs are bifid; and these double legs are analogous to the prolegs of caterpillars. The further course of growth is attended with a more distinct definition of the segments; and by transverse indents of the primary segments. The limbs also become more straightened. The whole period of development occupies four or five weeks, and then development is superseded by the mere actof growth.

With regard to the Centipedes, we still need a series of researches to make us properly acquainted with their development. A French naturalist has recorded a series of researches on the genus Lithobius. This is a modified centipede, consisting of seventeen segments, and having fifteen pairs of extremities. In the month of May, the larva presents but ten joints and seven pairs of legs with two simple ocelli on each side of the head. Early in June, it had acquired twelve segments, and eight pairs of legs, and the head presented three ocelli on each side. Later on in the same month, the segments had increased to fifteen, and the legs to fifteen pairs, and the number of ocelli was eight; finally, two more segments were added, and the cluster of ocelli included twenty on each side. The chief distinction between the Lithobius and Iulus appears to be, that the successive joints are not developed, as in the Iulidæ, at the posterior part of the body, from one particular germinal space, but at the interspaces of the pre-existing segments.

With regard to the affinities of the Myriapoda as they are illustrated by the known phenomena of their development, we discover in the peculiarly localised power of superadding the additional joints in the Iulidæ, a marked analogy to the annellides; yet the appendages of the segments being distinctly jointed limbs, we have in these a well-marked character of the superiority of the Chilognatha. Then, in reference to the Crustacea, which the Myriapoda more resemble in their jointed antennæ and limbs, we perceive also an interesting additional analogy in the Chilognatha, in the circumstance of the organs of the generative apparatus not terminating in the homologous segments in the male and in the female; whilst in both they are situated nearer the anterior part of the body. But this crustaceous character disappears in the Chilopoda. And when we perceive that the first form of the articulated animal with jointed limbs, which the Myriapoda assume, is that of the hexapod insect, and further, that in departing from this type, the pair of limbs successively added in the Iulus are like those temporary ones in the caterpillars, of a different character from the primary six,—we cannot but derive from these facts a well-founded confidence in the importance of that character of the respiratory system which led us, at the beginning, to class the Myriapoda with the Insecta rather than the Crustacea.

William Tyler, Printer, Bolt-court, London.

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DEATH OF SIR RICHARD OWEN.

We regret to announce the death of Sir Richard Owen, K.C.B., which sad event took place at three o'clock yesterday morning, at his residence, Sheen Lodge, Richmond Park, Surrey. Deceased, who was born on July 20, 1804, had been lingering for some time, and his death was therefore not altogether unexpected.

Sir Richard Owen's working scientific career extended over sixty years. Some of the results of his work have been given to the world in the form of special memoirs; some in papers communicated to different learned societies, and some in the form of lectures delivered at the College of Surgeons, the Royal Institution, before the British Association and elsewhere, of which many have been printed. In point of number of publications alone, few scientific men have left such a record. And when contemplation dwells for a moment on the amount of time required for each investigation, and the sustained thought necessary for the explanation of many of the problems the professor took in hand, the wonder arises how, with official and other duties to perform, so much was accomplished even in sixty years. For he was no recluse, but one who, devotedly fond of his work, genially appreciated companionship.

Born at Lancaster in 1804, the youngest son of Mr. Richard Owen, of Fulmer Place, Bucks, he attended the grammar-school of that town. In 1824 he entered as a student in the University of Edinburgh where Professor Monro (tertius) held the chair of anatomy and physiology. He attended the lectures of Jameson on natural history, of Hope on chemistry, and Alison on the institutes of medicine; but for anatomy, as about 300 students each year did, he attended the lectures of Dr. John Barclay, an "extra academic" lecturer. Sir Robert Christison, who attended his lectures, speaks, in his reminiscences, of Barclay as a wit as well as an anatomist. Mr. Owen attended his winter course on human and summer course on comparative anatomy, while at Edinburgh he helped to form the Hunterian Society, and in 1825 was its president. He probably did not then dream he would in a few years be the first Hunterian professor in London. During 1825 he went to Paris and heard some of Cuvier's lectures at the Jardin des Plantes. In his Reade Lecture in 1859 he spoke of Cuvier as "my chief instructor in zootomy and zoology." In the same year (1825) he entered at St. Bartholomew's Hospital, and was chosen by Abernethy as a dissector. In 1826 he became Member of the College of Surgeons (his fellowship was 1843), and in 1827 he "set up" as a general medical practitioner in Serle-street, Lincoln's-inn-fields.

What his energy and patient work would have made him as a practitioner was not destined to appear, for an event occurred that changed the whole course of his life. The Government had purchased Hunter's collection for £30,000, and entrusted the care of it to the College (Company it was then called) of Surgeons. The old company of Barber-Chirurgeons had disintegrated into separate bodies, and Sir Everard Home had commenced to catalogue the collection, but in 1825 had given up the task. Mr. Clift was at the time curator, and the *Lancet* aroused him to the need of proceeding with a catalogue. He needed some young assistant; Abernethy's eye had noticed Mr. Owen's energy, skill, knowledge, and perseverance when his dissector. He recommended Clift to secure Mr. Owen. This was done, and Mr. Owen left patients to others while he took in hand the lengthy task of arranging and describing the results of Hunter's labours. The great difficulty was to know the species of animals Hunter had dissected and preserved. Mr. Owen thought the collection of the Zoological Society might help him—a collection very inferior to the present, and, such as it was, turned to no scientific use. He took every advantage of the deaths that occurred, and became practically the society's first prosector. Though the descriptive catalogue took years to prepare, and occupied ten quarto volumes, the work remains "a monument" to Owen's energetic perseverance and a boon to students. There was wanted for the museum a living example of the chambered shells, such as ammonites and their allies, and a friend of Owen's sent a specimen of the "pearly nautilus." He dissected it, and wrote a memoir on it, in which he not only described the nautilus itself, but alluded to the light thrown by the facts learned upon other questions. This memoir was published in 1830. In the same year he read his first paper. It was on a surgical question about whether so deep-seated an artery as the iliac could be reached for tying. From this year (1830) onward he read so many papers that without the help of the Royal Society catalogue it would take a prolonged search to be able even to given approximately their number. Between 1830 and 1863 there were 311, and by 1873 the number had reached 368. All the papers to 1834 had reference to living animals. In that year he commenced describing fossil animals, Toxodon being the first (Proc. Geol. Soc.). From that time onwards the whole range of animal life, fossil and living, formed a subject for his ever-busy brain and frequent pen. Animal life, in its various forms, presented itself to his mind as one great whole. Among the vertebrates he saw one type running through the whole. He reduced to a diagram a typical vertebra capable of many modifications, and a typical skull of modified vertebra capable of apparently endless modifications. He entered into the study of the meaning of limbs in relation to the vertebræ, and in all his work he carefully looked to what former anatomists had done and thought. It was in 1848 he produced his "Archetype and Homologies of the Vertebrate Skeleton," and in 1849 his "Nature of Limbs." His Hunterian course in 1842 had been on the chief modifications of the mammalian brain; and in 1859 he proposed a classification based on brain development. A long study of forms of teeth in vertebrates led to the publication of his "Odontography" in 1840, one thick octavo volume of letterpress, and another of plates, for most of which he made the drawings himself till his sight was affected by the work. He also worked at and published on the marsupials (kangaroos, &c.), and on the brain of marsupials. The collateral remarks he made on comparisons with other animals were afterwards used as facts to establish some of the new views he put forward.

One conclusion at which Owen arrived from his work was that there was progressive development from one form to another. For not maintaining the old belief that each species was the result of a special act of creation, he was charged with being an atheist or a pantheist. But he clearly states that progressive development leaves the question of "vitality" and original creation quite untouched, and when he refers to these subjects, it is in a tone of profound reverence. He took no part in the "materialistic" controversies of later times. Not only was he an exact observer, a skilled manipulator in dissections and microscope preparations, a clear writer and clear lecturer to audiences where technical terms would be understood, but as a popular lecturer his manner was marked by a peculiar felicity. In his genial after-dinner speeches this felicity was observable. There was no straining at effect, no attempt to make a "hit," and yet what was said was said with charm of manner. Those who never heard him may gather something of his manner by reading his Friday evening discourse at the Royal Institution on Feb. 9, 1849, "On the Nature of Limbs," when he put in popular form the result of many years of work. On five occasions he gave evening addresses before the British Association; in 1843 at Cork on "The Dinornis of New Zealand"; in 1846, at Southampton, on "The Fossil Mammalia of the British Islands"; in 1851, at Ipswich, on "The Distinction between Plants and Animals"; in 1854, at Liverpool, on "Anthropomorphous Apes"; and in 1858, at Leeds, on "The Fossil Mammalia of Australia." It would be interesting to know what he would have said in reply to the President's brief eulogium when a few years ago the first Linnean gold medal for zoology was handed to him. In receiving other honours there had been predecessors—in the case of the ancient Copley medal of the Royal Society many. Here he stood first in the line of those to come in pursuing a science he had done so much to modify—perhaps reform would not be an exaggerating word. This newly-created honour was the last he would receive; others were his already from many countries. He seemed about to speak, the audience was in complete silence, but after a few seconds' pause, in which effort and emotion were visibly in conflict, he only bowed his recognition to workers in science younger than himself.

For some time Professor Owen held a Fullerian chair at the Royal Institution, and though the lectures there were then, as now, largely attended by ladies, he was as successful in clear and pleasant style as in reading a paper at a learned society. He by no means thought that science should be cultivated only by the wealthy, nor that scientific works and lectures should be costly. He lectured to young men's Christian associations, and wrote on "The Skeleton and the Teeth." In addition to his own scientific work he was appointed one of the commissioners to inquire into the health of towns, and was one of the three commissioners (Edwin Chadwick and Southwood Smith being the others) to inquire into the sanitary state of the metropolis. He was also actively engaged in connection with the Great Exhibition of 1851. His latest administrative work was the drawing up of the scheme for the new Natural History Museum at Cromwell-road, which was beset with many difficulties. As the introduction to the general guide to the museum gives an outline account of its rise, there is no need to refer here to what was a great and anxious work.

It has been the fate of some hard-working pioneers in science to be neglected by their contemporaries. This was not the case with the late professor. From the Geological Society he received the Wollaston medal, the highest award they can make; from the Royal Society first a royal medal and afterwards the "Copley," the ancient olive crown of the society, as it has been called. He also received the triennial Cuvier medal. As already stated, the Linnean Society gave him its first gold medal for zoology. He was an honorary member of every scientific society of importance in Europe. The King of Prussia bestowed on him the Order of Merit, and he received the Cross of the Legion of Honour. The Queen, in 1852, granted him Sheen Lodge, Richmond Park, as a residence, and conferred on him first a C.B. and then a K.C.B. In 1858 he was president of the British Association at the Leeds meeting.

REMINISCENCES OF THE LATE SIR RICHARD OWEN.

England has lost another great man, and the scientific world one of its most brilliant luminaries, the last link between two generations of scientists. Sir Richard Owen, full of years and honours, venerable and venerated, passed peacefully away after a lingering illness on Sunday morning, at Sheen Lodge, Richmond Park, the residence granted him by Her Majesty the Queen, at the request of the Prince Consort, who appreciated and valued the remarkable powers and good qualities of England's great anatomist. It was the Prince also who was mainly instrumental in securing Professor Owen's appointment in 1856 as Superintendent of the Natural History Branch of the British Museum, a post which was especially created for him, and which he held with honour to himself, and with great benefit to the Museum and to the general interests of Science for nearly a quarter of a century.

At one time Professor Owen gave lectures on Natural History to the Royal Family; he was deservedly a favourite in Court circles. The following message was received by the family from Osborne, through Sir Henry Ponsonby: "The Queen is much grieved to learn the sad news of Sir Richard Owen's death and commands me to express her sincere condolence;" and the Prince of Wales, who had called personally during his illness, sent a message to Princess Mary, Duchess of Teck, who conveyed it to her neighbours across the Park: "Will you kindly express in my name my deepest sympathy with Sir Richard Owen's daughter-in-law at the loss of her distinguished father, such an old and valued friend of mine.—ALBERT EDWARD." It was the intention of the various learned Societies of which the Professor has so long been a member, and once President, to make the usual representation to the Dean of Westminster, soliciting permission to inter Sir Richard Owen's remains in Westminster Abbey, but the idea was abandoned immediately it was made known that Sir Richard Owen had left written instructions requesting that he should be buried by the side of his wife in Ham Churchyard. The simple ceremony took place yesterday (Friday) afternoon, and was numerously attended by all the élite of his contemporaries, the Trustees and officials of the British Museum, and representatives of the various Scientific Societies, among whom Sir William Flower, Sir Joseph Fayrer, Dr. A. Gunther, F.R.S., Dr. P. L. Sclater, F.R.S., and others were present as a deputation from the Zoological Society, with which he had been associated since its foundation as the chief contributor to its Transactions and Proceedings.

Professor Owen, to give him the familiar title by which he was known and respected all over the world, was the youngest son of Mr Richard Owen, of Fulmer Place, Bucks. By birth he was a Lancashire lad, as he first saw light at Lancaster, on July 20th, 1804, and it was in that town that he received his early education at the Grammar School, where he had Whewell, afterwards the famous "Master of Trinity," for a comrade. Very early in life, as was then the custom, young Owen entered the Navy and served as midshipman on H.M.S. Tribune. But the sudden close of the war with America and France, in 1814, abruptly extinguished his naval aspirations. His friends recalled him ashore and he had to return to school, and was afterwards apprenticed to a surgeon in Lancaster. He graduated in medicine at Edinburgh University in 1824, and two years later received his diploma of the Royal College of Surgeons in London, where, as a student at St. Bartholomew's Hospital, he had fortunately, by his skill in dissection, attracted the attention of the famous Dr. Abernethy. It was entirely owing to the vigorous representations of this eccentric friend that he again gave up the sea life he longed for and resigned an appointment as Assistant-Surgeon in the Navy, which he had applied for and obtained. Dr. Abernethy procured him a temporary post as assistant to Mr William Clift, F.R.S., the devoted conservator of the great John Hunter's collections in the Royal College of Surgeons. The preparations and specimens had been left in sad disarray, without names or labels, and it was Owen's task to help to identify, classify, and arrange them. For a short time he also practised as a surgeon, in Serle-street, Lincoln's Inn-fields. At this period he first made the acquaintance of Baron Cuvier, who, owing to a political crisis in France, was then in temporary retirement in London. Soon after Cuvier's return to France Owen found means and opportunity to visit Paris, where he studied in Cuvier's laboratories. There is little doubt that the magnificent palæontological collections which had been formed by the great French *savant* exercised an important influence on the direction of Owen's subsequent researches, and it was by his restorations of extinct animals that the English anatomist first became generally famous.

On returning to London, Owen was definitely appointed Assistant to Mr Clift, whose only son was accidentally killed, and it fell to his lot to console the bereaved father, to win the heart and hand of his only daughter, and to help him in his official duties. On Mr Clift's death Owen was made Conservator, and held the post for many years afterwards. During that period he named and arranged the entire Hunterian collections, and published the various descriptive catalogues of the preparations which made his scientific reputation. Owen first received the title of Professor on his election to the first Chair of Anatomy, founded at St. Bartholomew's Hospital in 1834. In 1836 he was appointed to the Hunterian Professorship in the College of Surgeons, and his lectures and demonstrations to the medical students in this capacity furnished the material for his great works "On the Comparative Anatomy of the Vertebrata" and "The Invertebrated Animals," which have passed through many editions.

One of Professor Owen's most remarkable memoirs was that on the animal of the Pearly Nautilus, published when he was only twenty-seven years of age. He was but thirty when he received the honour of election as a Fellow of the Royal Society, which awarded him in after years the Copley and Royal Medals. He received the Wollaston Medal of the Geological Society, was elected President of the Geological Society, of the Zoological Society (to which he acted as unpaid Prosector for many years), of the Linnean, the Microscopical Society, and of the British Association. By his devotion to microscopic research Owen nearly lost his eyesight in preparing his magnificent work on "The Microscopic Structure of the Teeth (Odontography)." But it is not possible to refer to all the honours awarded him by his confrères and received from foreign Sovereigns during his arduous career of research, nor is this the place to enter on technical details of Sir Richard Owen's herculean scientific labours. A full account of his life and biological investigations will be published in the January number of *Natural Science*. Here we can give but an outline.

Fifty years of Owen's life were devoted to incessant and arduous original research in all classes of the animal kingdom, from the lowly sponge to the great whale, from parasites to primates and patriarchs.* All lands, every ocean, and each fossiliferous geological horizon has yielded subjects either for his scalpel or his pen. He has written on sponges, parasitic entozoa (*Trichina spiralis*), crustaceans, brachiopoda, and all kinds of mollusca; on the veritable sea snakes, and mythical sea serpents. The mud-fishes of Africa and America, turtles, tortoises, crocodiles of living and extinct species, the swimming lizards (*Enaliosauria*) of the medieval oceans, and the flying reptiles of the air (*Pterodactyla*), of long past epochs, all formed the subjects of his memoirs. He has described strange "beast-toothed" (*Theriodont*) reptiles, from the Trias of the Cape of Good Hope, the grand bipedal Iguanodons of our Sussex Wealden, and the extinct wingless birds of New Zealand. He has made proverbial the name of the extinct dodo, or great ground dove of the Mauritius, and thrown light alike on the structure of the fossil ostrich (*Dasornis*) and the toothed bird (*Odontopteryx*) of the London Basin, and on that ancient land bird, the famous long-tailed *Archæopteryx* from the Jurassic strata of Solenhofen. For thirty years the kangaroos of Australia engaged his attention at intervals, with the result that at last he was able to build up a complete restoration of *Diprodon Australis*, a fossil form of gigantic dimensions. He has studied the elephants and mastodons from the Sewalik Hills, and the rhinoceri and mammoths of old time in Essex. He gave an excellent review of the progress of general Palæontological science, to which his researches so largely contributed, in his article entitled "Palæontology," in the eighth edition of the "Encyclopedia Britannica." The magnificent results of Owen's vast labours on the extinct animals of his own country will be found epitomised in the "History of British Fossil Mammals and Birds," and detailed in the volumes of the Palæontographical Society of Great Britain, of which he was one of the founders and many years President. Several of his fossil type and figured specimens from the Bracklesham beds of Sussex, the chalk and the Wealden, may be found in the Willett Chalk Collection the Holmes Collection, and the Tertiary Series in our Brighton Museum.

The living ant-eater and aye-aye from Madagascar served the Professor as a text for an Exeter Hall lecture before the Young Men's Christian Association. His lectures to the medical students in the theatre of the Royal College of Surgeons were often attended by the celebrities of the day, so great was his fame as a demonstrator. He lectured on the extinct animals of the British Colonies before the Colonial Institute. He often addressed the geological students at the School of Mines in Jermyn-street, and was equally at home lecturing on general natural history before the Royal Family, with the Prince Consort to point out the diagrams, or addressing an assemblage of working men on a Saturday afternoon in the galleries of the British Museum. It was once our privilege to see and hear him demonstrate to the members of the Geologists' Association in the old galleries of the Bloomsbury Museum as, his grand figure dominating the circle, "with big bone in hand" he fascinated his hearers, and made "the dry bones live" by his vivid pourtrayal of the structure and habits of the extinct creature of which it once formed part, and pictured its associates and its surroundings. A report of this address formed the subject of our first communication to this journal.

Sir Richard Owen did good service as a citizen as well as a man of Science. He served on the Commission of Inquiry on the health of towns and was thus instrumental in securing a good water supply for his native town, Lancaster; on the Commission on the Meat Supply of the Metropolis, which resulted in the removal of the cattle market from Smithfield to Copenhagen Fields. He was a Commissioner of the Great Exhibition of 1851, and prepared some of the official guide books on animal substances (pearls), and was a mem-

* "The Science of Life and the Longevity of the Patriarchs." *Fraser's Magazine*, vol. 53, 1856.

ber of the Jury on Food Products at the Paris Exhibition in 1855. But his greatest service to the nation and to the world of science in general undoubtedly sprang from his meritorious and long continued representations to the Treasury officials concerning the overcrowded condition of the British Museum. It was mainly due to his persistent efforts, his courage and perseverance, to the force of his unerring logic and of his universal fame as the foremost representative of English Science that we owe the National Natural Museum at South Kensington. His position and reputation enabled him at last, by constant pressure, to induce the Government of the day to bring in a Bill in Parliament to sanction the removal of the natural history collections from the Bloomsbury Museum, and to secure a site and erect a fitting building not only to contain them but to permit of that increase and extension which the progress of natural science demanded for the future. We do not know what Sir Richard Owen's political opinions were, but we believe he found it hard to forgive Mr Disraeli for his ill-timed opposition, on economical grounds, by which the Bill Mr Gladstone, as Chancellor of the Exchequer, had brought in on May 12th, 1862, was thrown out by a majority of 92 in a House of 234 Members, in spite of Lord Palmerston's offered compromise "to exclude whales altogether from disporting in Kensington Gardens."

During the recess Owen was summoned to Hawarden to consult with Mr Gladstone, who, as one of the Trustees of the British Museum, had become personally convinced of the justice and reason of Owen's demands in the national interests of Science. The plans were drawn out and discussed with Sir Henry Hunt, and next Session the campaign was again vigorously opened, and this time it terminated in a victory, as the Bill was passed and supplies voted for the purchase of a site and the erection of a suitable building at South Kensington, which was not completed, however, until ten years afterwards.

But the philosopher triumphed in the end and lived to preside as first Director of the Natural History Branch of the British Museum at South Kensington, an institution which is a credit to the country and an enduring memorial of the philosophical foresight of Owen. He retired in 1883, and was then created a Knight Commander of the Bath. The history of this truly great achievement will be found in Professor Owen's influential "Report on the Extent and Aims of a National Museum of Natural History," which rapidly passed through two editions, and in his address to the Biological Section of the British Association at the York Meeting in 1881.

Sir Richard Owen, unlike many of the votaries of Science, was very fond of animals. He loved Art, music, and poetry, and was well-read and an accomplished musician. The "cello" was his favourite instrument. Of tall imposing presence, with a fine head and magnificent eyes beaming with intellect and geniality, he presented a very picturesque appearance, and looked the philosopher he was. He possessed the courtly manners of the old school, wrote charming letters, and excelled as a *raconteur* of the many good stories his life experiences furnished. He had known the most notable men of his time in the literary, artistic, musical, and scientific world and in all ranks of society, and was an afternoon visitor at the Deanery, Westminster, in the days of Dean Stanley, when the Queen was occasionally able to meet there some of the most distinguished of her subjects in an informal manner.

The great Scientist found time to stay in Brighton a few years ago, and it was then we shared the privilege of accompanying him on his visit to the Aquarium, then worthy of a naturalist's inspection. He enjoyed the opportunity greatly, saluting, with uncovered head, his "old friends the king-crabs, on account of their ancient lineage," and expressed much delight in watching the manœuvres of a fishing-frog or angler, in a table tank. He had minutely described the anatomy and the mechanism of the flexible rod and baited line characteristic of this genus, but had never seen a living specimen before, and watched with profound interest the creature raise its rod and ply the bait and attract thereby a foolish, over-curious fish which came too near, when the angler rose up swiftly and, with a rapid gulp of its most capacious jaws, swallowed up its victim.

Professor Owen married in 1835 the only daughter of Mr William Clift, F.R.S., by whom he had an only son, who pre-deceased him. He was left a widower, and for many years his venerable sister shared the charming home in Richmond Park, to which many distinguished men and women made a pilgrimage to enjoy the charms of the veteran's conversation and reminiscences. Sir Richard Owen's declining years were soothed by the devoted solicitude of his daughter-in-law, Mrs William Owen, and his grandchildren. He leaves four grandsons to mourn his loss. The eldest, the Rev. Richard Startin Owen, M.A., is an accomplished linguist and musician. Mr Frank Owen, C.E., pursues his profession in Colombia. Both received their early education at the Wick, in Brighton. We believe Sir Richard Owen was occasionally occupied of late years in dictating his recollections to his eldest grandson, to whom we must now look for the reminiscences of the eventful career and life-work of the greatest anatomist of his age, as Humboldt called him. Alas, that we can no longer say "the first of *living* naturalists."

AGNES CRANE.

Morning Post. Dec 24th 92.

FUNERAL OF SIR RICHARD OWEN.

Yesterday the remains of the venerable physiologist, Sir Richard Owen, were interred, with the simplest rites of the Church, in the little rustic graveyard at Ham, Surrey. The afternoon, though fine, was bitterly cold, but there was a large and representative gathering of scientists present to pay a last tribute of respect to the memory of a man who, in his own person, had linked together several generations of those engaged in comparative anatomy, natural history, palæontology, and cognate branches of research. The funeral procession, which left Sheen Lodge, Richmond, shortly after two o'clock, consisted of an open car and two mourning coaches. The Rev. Richard Owen, the late professor's eldest grandson, was chief mourner, and the other mourners were the Hon. Lyulph Stanley, Dr. Palmer, Sir William Flower, Director of the Natural History Museum, and Mr. Thomas Bryant, President of the Royal College of Surgeons. Among those present in the church and at the graveside was the Duke of Teck, who brought a large wreath of white chrysanthemums, lilies, and maidenhair fern, to which was attached a card with the words, "A last token of sincere admiration and affection from his old friends, the Duke and Duchess of Teck." Other wreaths were sent by the Earl of Leven and Melville, Lady White Cooper and Miss White Cooper, Mr. and Mrs. Holman Hunt, and the Master and Wardens of the Leathersellers' Company, of which Sir Richard Owen was an honorary liveryman, as well as by relatives and private friends.

The friends and professional associates of the professor who attended the funeral included Sir Mountstuart Grant-Duff, Sir George Bourchier, Lady Ellis, Sir Duncan Campbell, Sir John Evans, Treasurer of the Royal Society; Sir Joseph Fayrer, Professor Judd, Vice-President, and Dr. H. Hicks, one of the secretaries of the Geological Society; Professor Charles Stewart, President of the Linnean Society; Dr. R. Hingston Fox, joint-secretary of the Hunterian Society; Professor M. Foster, joint-secretary of the Royal Society; Lieutenant-Colonel G. Austen; Mr. P. L. Sclater, secretary of the Zoological Society; Mr. Howard Saunders; Dr. Forsyth Major, of Florence, representing several Italian scientific societies; Mr. W. Arnold Hepburn, representing the Leathersellers' Company; Mr. J. W. Sharp, representing St. Bartholomew's Hospital; Professor H. G. Seeley, Mr. H. Goss, honorary secretary of the Entomological Society; the following, among other gentlemen, from the Natural History Museum—Mr. Charles E. Fagan, assistant secretary; Dr. Albert Günther, keeper of zoology; Dr. Henry Woodward, keeper of geology; Mr. William Carruthers, keeper of botany; Mr. Charles O. Waterhouse, and Mr. A. Smith Woodward, a representative from the Lancaster Grammar School, where Sir Richard Owen received his early education; and Mr. Frederick Lingard, his personal attendant for upwards of 30 years. The coffin, upon which lay his robe as first Hunterian Professor, bore the following inscription, "Richard Owen, died December 18, 1892, aged 88 years."

The remains on arrival at the church were received by the officiating clergy, the Rev. A. S. Smith, vicar of Mortlake, and the Rev. T. G. P. Hoag, vicar of Ham, and the Service was conducted throughout without the aid of organ or choir.

Photo by Gunn and Stuart, Richmond.

SHEEN LODGE, RICHMOND, WHERE SIR RICHARD OWEN DIED.

THE ILLUSTRATED LONDON NEWS, Dec. 24, 1892.—

SIR RICHARD OWEN.

Sir Richard Owen, K.C.B., F.R.S., the news of whose death, which occurred at three o'clock on Sunday morning, Dec. 18, has occasioned wide regret, was born at Lancaster, July 20, 1804. On leaving school he entered the Navy as a midshipman, but on the restoration of peace in 1814 he began the study of medicine, first in Edinburgh and then in London, and in 1830, after three or four years of private practice, was appointed curator of the Hunterian Collection in the Royal College of Surgeons, of which institution he had been admitted a member four years previously. The position which Sir Richard's talents thus early secured him relieved him from the uphill struggle of a medical man's life, and united both his duties and his tastes in the advancement of the sciences of physiology and comparative anatomy. A long and useful service to these kindred branches was continued in a yet wider field by Sir Richard's appointment in 1856 as Superintendent of the Natural History Department of the British Museum, which post he held till 1883, thus retiring in his eightieth year to well-earned rest, in the little cottage in Richmond Park which had been accorded him by the royal bounty as far back as 1851. The results of scientific work extending over half a century are scattered through numerous memoirs and minor treatises, but are specially embodied in Sir Richard's *magnum opus*, "The Comparative Anatomy and Physiology of the Vertebrate Animals," which fills three volumes. To write the biography of Sir Richard Owen is to write the history of biological science during the past fifty years. And much more than that, because the public movements with which Sir Richard has been connected have not been limited to his own area of research. The noblest monument of his perseverance, in the teeth of both lay and official opposition, is the spacious building at Kensington, to which in 1881 the long "cramped and cabin'd" natural history collections were transferred from Bloomsbury. It is there that, as already expressed in this Journal, we hope to see Mr. Holman Hunt's portrait of the savant hung as a national tribute to one of the chief among the founders of modern biological science.

Among the influences on Owen's life-work, probably the most powerful was that of the great anatomist Cuvier, under whom he had the good fortune to sit as student for a time in Paris. For Cuvier was the modern father of comparative anatomy. In his "Règne Animal," published in 1817, he shows that the agreement between the different parts of an animal is so close that the knowledge of any one part gives the clue to the whole structure, and therefore to the nature and habits of the animal; which is a scientific setting of the old saying, *Ex pede Herculem*—we can tell whether he be Hercules from the length of his foot. But as the perfection (to which term much exception has to be taken) of the organs of animals for the work which they do led Cuvier to think that the organs were created expressly for the functions which they serve, he could not accept the doctrine of homology, or the likeness of corresponding organs in animals as regards structure and type, as, e.g., between the fore leg of a quadruped, the wing of a bird, and the arm of a man, which are of kindred origin, but modified through long and lateral descent for the work which they do. The influence of the master's views on the disciple has been manifest through the career of the latter, arresting his development in certain directions. This is shown in Sir Richard's attitude towards Darwinism, an attitude, for different reasons, adopted by Mr. Wallace, St. George Mivart, and other men of science who do not accept the theory that no break exists in the chain of physical and psychical life between the lowest and highest organisms. In Darwin's "Life and Letters," speaking of the varying reception expected for "The Origin of Species," he says of Owen, "Dead against us, I fear." And with reason; for in 1857, two years before the "Origin" was published, Sir Richard had committed himself to certain statements as to differences between the brain of man and the higher apes which are proved not to exist—statements to which Professor Huxley gave a direct and unqualified contradiction when Sir Richard repeated them at the meeting of the British Association at Oxford in 1860. In science, as in things of graver import, a man cannot, save at the cost of losing abiding influence on his fellows, halt between two opinions. He must adhere either to the old pre-Darwinian view of the immutability of species, of their special creation as and wherever found; or to their mutability, the common descent of every plant and every animal from formless or seemingly structureless specks of matter which, through an infinite series of changes, have become modified into the teeming forms that have flourished or that now flourish on the earth.

But if the powerful voice of Sir Richard Owen has in this high matter uttered an uncertain sound, no man has done so much as he to re-create the past, in visiting the "valley of dry bones," and informing these relics with the strange, uncouth life that endowed them; and in restoring in vivid outline that ancient world when huge "dragons of the prime" wallowed in the basins of the Thames and Seine, and when, later still, wild carnivora as lions, hyenas, and their kin, contested with man the supremacy of the sites where now London and Paris stand. On such a man, to whose eminence no titular dignities can add, honours have been showered by learned bodies at home and abroad, and by the Universities whose portals so few among the men distinguished in science have entered, save to receive the honorary degrees conferred upon them for work to which, until recently, those institutions have given neither smiles nor support.

HUNTERIAN LECTURES

ON THE

GENERATION AND DEVELOPMENT OF THE INVERTEBRATED ANIMALS.

By RICHARD OWEN, F.R.S.

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[*Reported expressly for the Medical Times, and revised by the Lecturer.*]

LECTURE XV.(a)

GENERATION OF INSECTS. — Business of generation in Hexapod or "True" Insects committed to four kinds of individuals, — Males, Females, Neuters or nursing-females, and procreant virgin larvæ. Division of the class according to generation-characters into Ametabola, Hemimetabola, and Metabola. — General structure of the male organs. Chief modifications exemplified in species of Aptera, Hemiptera, Orthoptera, Diptera, Lepidoptera, Hymenoptera, Strepsiptera, Neuroptera, and Coleoptera. Analogy of the organs in their numerous and various forms and occasional bright colours to flowers. Monogamy or Polygamy in Insects governed by the structure of the intromittent organ. External outlets of sperm-ducts remote from that of the vesiculæ seminales and from the penis in the Dragonfly.—General characters of the female organs: exceptional simplicity of those of the procreant larval Strepsiptera and Aphides. Chief modifications of the female organs illustrated by parallel instances to those of the males. Modifications of the vulva, and its appendages the ovipositor and sting. Various uses and applications of the colleterial secretion. External sexual characters. Abnormal Hermaphroditism.

MR. PRESIDENT AND GENTLEMEN,—In the generative organs of insects, as in those of plants, Nature seems to have been prodigal in her power of producing endless varieties of forms out of one common type of organ, and subservient all the while to one common end or office; and the analogy to the reproductive flower is the more striking, from the brilliant colours which the essential parts of generation assume in some species of insect. But all insects are dicœcious; the individuals are of distinct sex. And there are not only "males" and "females;" but, in certain families of true or hexapod insects, there are other kinds of individuals, which are essential to the successful propagation of the species. In the social families of Bees and Ants, for example, there is a third form or condition of the individual, commonly called "neuter," and sometimes labourer or nurse. But, these are essentially female; having the female organs but imperfectly developed and passive. The working bee, at least, exercises the function of only one part of those organs, an accessory part, which is metamorphosed into a special poison organ, but which is the homologue of the ovipositor in fertile female insects. This working bee, or "non-breeder," as Hunter called her, relieves the parturient queen of her ova, places them in the appropriate nest-cell, and feeds the larva when it is hatched: it thus acts the part of midwife as well as nurse, and is an indispensable adjunct to the multiplication of the species. There is, again, in insects, a fourth modification of the individual, in relation to the sexual function. I allude to that remarkable state of the *Aphis*, which, like the working bee, is an arrested stage of the female constituting the larviparous individual, which propagates by a kind of internal gemmation, without sexual concourse in her own person. She possesses, however, the female organs; but, contrariwise to the working bee, it is the external and accessory parts of the apparatus that are wanting, whilst the more essential organs are extremely active. Thus, at the outset of our survey of the generative system and function in hexapod insects, we encounter four different kinds of individuals in relation to that function:—males, nubile females, sterile females, and procreant virgins.

Certain modifications of the generative functions have served as a basis for the classification of the hexapod insects, some of which, as *e. g. aptera*, are said to undergo no metamorphosis, and have been called "ametabola." Others, as *e. g.*, the *hemiptera* and *orthoptera*, are described in entomological treatises as undergoing only a partial metamorphosis, and are called, "hemimetabola." The metamorphosis being more patent and conspicuous in the rest of the class, is admitted, said to be perfect or complete, and made the characteristic of the "metabola." The divisions so founded and defined are insufficient, however, for the generalisations of the comparative anatomist, and, by that very defect, are evidently less natural than the orders in the Linnæan system, from the characters of the wings, which I have here adopted.

I proceed now to demonstrate the structure and modifications of the organs or instruments subservient to the retention, nourishment, and transmission of the sperm-cells and germ-cells, and their products or developments; and, first, of the parts called the "male organs." In entering upon a review of the structure of the male organs of insects generally, we found their simplest type in the lowest organised members of the class, viz., the chylognathic myriapodr. The testes and their ducts, with short and simple intromittent organs, alone existed; there were no accessory glands, no mechanical adjuncts in relation to the coitus. The sexual apertures, on the seventh primary segment, though near the anal end of the body in the nine-jointed larva, become advanced much nearer the head in the fully developed iulus, by reason of the vast superaddition of joints, through the successive sextuple gemmation of segments between the penultimate and antepenultimate primary segments of the larva. In the chilopoda, the ordinary insect-type of the generative apparatus was more nearly approached, by not only the more definite boundary between testis and vas deferens, but by the termination of the sperm-ducts at the anal segment, and, likewise, by the presence of accessory glandular organs.

Testes, with distinct sperm-ducts, and superadded glands are present in all hexapod insects; and in all, with a few exceptions, the sperm-ducts open at the base of an intromittent organ, developed from the anal segment.

The testes are remarkable for the endless diversity of their forms, and often for the bright or brilliant-coloured pigment which besets the *tunica vaginalis;* in both characters reminding us of the flowers of plants. They appear to form a single organ in most Lepidoptera, but are actually two confluent testes, and were originally distinct in the larva of all that beautiful order.

In most insects the testes form a distinct pair of glands; but their cœcal structure, and the gradational development of the secerning follicles at length produces a seeming multiplication of testes, and it is difficult to avoid giving this definition to the six clusters of spermatic cœca, with their six ducts, on each side in the dung-beetle, *Scarabæus*, or to the twelve flattened circular glands, with as many ducts, which represent the testis on each side in the rose-beetle, *Cetonia*.

In all these cases, however, the ducts from the divisions or distinct lobes of the testis rapidly unite to form the beginning of a single *vas deferens* on each side; and the essentially paired character of the

(a) The 14th lecture, in our Number of November 24th, 1849, was, by mistake, printed as being the 13th, which appeared in the Number for November 10th.

and Comparative Anatomy in the Museum of the Royal College of Surgeons, which occupies five

was marked by many bitter controversies which one would rather not recall. Considering the long period

testes is manifested by the pair of *vasa deferentia*, whether the character be masked in the gland itself by confluence, as in the butterflies, or by multifid division, as in the beetles.

In the *Aptera*, Treviranus has given a good description and figure of the male organs of the *Lepisma*. The testes are represented by four or five elliptical glands, the slender duets of which soon communicate with a common *vas deferens*, which, after a loug fold, descends and dilates into a sperm-reservoir on each side. The accessory prostatic glands are bent upon themselves, like a common magnet; one end of each opens into the *ductus ejaculatorius*.

In the order *Diptera* the testes always present themselves as two simple glands, the outer capsule of which is of a brown or yellow colour; in the *Asilus*, when this outer coat is removed, the surface of the testis is nodulated by the prominent ends of the component cœca; two slender sperm-ducts terminate in a small sperm receptacle, which also receives two long filamentary prostatic glands; a long *ductus communis* is then continued to the base of a trifid penis.

In many of the *Lepidoptera*, the testis is clothed with bright pigment, crimson in the common white butte fly (*Pontia Brassicæ*), and green in the Sphinx. In most of the species the two glands approximate, and become confluent in the progress of the metamorphosis; but in certain moths, as, *e.g.*, the *Tinea*, the originally distinct condition of the testes is retained in the imago state; the testes also remain distinct in the Yponomeuta. In most *Lepidoptera* the *vasa deferentia*, or sperm-ducts, after a short course, receive two capillary prostates, and then a long and convoluted *ductus ejaculatorius*. What is remarkable in some butterflies (*Pontia, e. g.*), is not only the great length of the prostatic gland, but also the extreme length and winding convolutions of the common terminal duct. The structure of the intromittent organ in the Lepidoptera is such as to preclude the repetition of the act, and they consequently live in a state of compulsory monogamy. The bifid hooks on the terminal segment of the dorsal valve of the penis, whilst they serve to retain the female, prevent the extrication of the virile organ in a state fit for repetition of the act.

With respect to the order *Hymenoptera*, Hunter has left some good dissections of the male organs in the bee. We observe here, (showing the preparation,) that the testes are of a simple oblong form; but, when we dissect away the capsule or "tunica albuginea," we expose many long cœcal tubes, which, as they uncoil and float in the liquid, give a bushy character to the gland. The sperm-duct rises from near the middle of each testes, and soon swells into a large cellular reservoir common to it, with the openings of two pyriform prostatic glands, whence a common ductus ejaculatorius is continued to the base of the intromittent organ. Mr. Newport has given a good description and figures of the male organs in a wild bee (*Athalia centifolia*,) in which we have the same characteristics; the testes are two in number, but lobulated; the sperm-ducts are expanded, but are convoluted into a kind of epididymis, answering to the reservoir in the hive-bee; from this part the duct extends to the neck of the prostatic sac, which repeats the bent form. The short ductus ejaculatorius terminates at the base of a virile organ, covered by two pointed plates, beset with soft hairs. Above these are two other irregular, double jointed plates, folded somewhat fanwise, and furnished with horny hooks. Between these are two muscular parts, which immediately enclose the intromittent organ.

As an illustration of the male apparatus in the order *Hemiptera*, I shall select the *aphides*. The male insect is winged, and is commonly smaller than the winged female. The internal organs of the male consist of six oval testes, two larger and four smaller, so closely impacted together as to resemble a single sexlocular organ. The two gently convoluted sperm-ducts proceed close together from the testes and open externally, in common with the ducts of two long, colourless cœcal appendages, upon a soft, unarmed penis. These appendages never contain spermatozoa; they are a simple form of accessory prostate. The spermatozoa are found in various degrees of development in the testes; when fully developed, they form oval bundles of very fine filaments, which separate in water, at one end expanding like a bunch of flowers. The intromittent organ is not broken away *in coitu*, and the male aphis may, therefore, enjoy a frequent repetition of the act.

In the order *Orthoptera*, we find the locusts with testes composed of numerous blind tubes, in most species enclosed in a common capsule. The prostatic glands also consist of fasciculi of tubes, and remind us of the condition of the prostate in some rodentia.

The order *Coleoptera* offers the greatest diversity in the form and structure of the male organs. In the *dytiscus*, each testis is a filiform tube, much longer than the abdomen, but convoluted into a round ball. In the *hydrophilus*, the gland is represented by a series of short blind processes given off from one side of a common sperm-duct. In the *buprestis* a fasciculus of longer cœcal tubes radiate from the end of the sperm-duct. Sometimes the extremities of similar radiating tubes are dilated into sacculated flattened glands, as in the rose-beetle, (*cetonia*,) and numerous more composite forms have been detected; all, however, are referrible to modifications of the primitive blind secerning sac. Their analogy to the sexual parts of plants has already been alluded to, and entomologists have found it requisite or advantageous to borrow the neat and descriptive terms, with which Linnæus has enriched botanical science, in order to indicate the diversified forms of the male apparatus in the subjects of their favourite class. The intromittent organ is a long horny tube; usually retracted within the abdomen, but not capable of retraction after complete intromission, which usually terminates by rupture of the organ. Hence the *coleoptera*, like the *lepidoptera*, are monogamous. The terminal portion of the ejaculatory duct is continued into the penis, and, in the *carabus clathratus*, opens upon the centre of a soft glandiform termination of the intromittent organ.

Much unity of plan may be traced throughout the varied modifications of this organ in insects. In general terms, the intromittent organ may be defined as a modification of the last, or two last, segments of the abdomen. It consists of a large exterior sheath and a delicate membranous tube; the sheath commonly consists of two lateral valves. It is usually retracted out of sight. Accessory prehensile organs are developed in some insects, of which the most remarkable are those which are attached to the base of the abdomen in the male Libellula. In this remarkable insect, the sperm-ducts terminate, as usual, on the anal segment; but the vesicula seminalis is situated at the base of the abdomen. The semen is transferred thither by a strong inflection of the caudal end of the abdomen, prior to the coitus, and passes from the sperm reservoir into the vulva of the female, which is retained in contact with the basal joint by the claspers attached to that part.

The spermatozoa in all hexapod insects are filiform, and often remarkable for their extreme length; the anterior extremity is usually thickened for a considerable extent.

The sperm-cells usually contain many "spermatoa," or vesicles of development; these spermatoa are at first transparent, then granular, and lastly, the spermatozoon is developed, one in each. This makes the spermatoon change its form. It is stretched by the uncoiling of the spermatozoon, and at last bursts and allows the spermatozoon to escape. Thus let free in the common sperm-cell, they groupe themselves into regular bundles. Sometimes these fasciculi resolve themselves, and the spermatozoa disperse as soon as the sperm cell gives way; but usually a part of sperm-cell remains as a partial sheath to the bundle, and when the spermatozoa remain in this way closely packed together the whole bundle might be taken for a gigantic spermatozoon. The bundle is very long, and appears convoluted in a knot in staphylinus, but is resolvable into its constituent spermatozoa, which become separated as they advance along the sperm-duct.

But here frequently, by the addition of the prostatic secretion, they are again collected into fresh bundles, and packed up into "spermatophora." These secondary aggregates present an elegant arrangent in the *Locustinæ*, being delicately barbed like a feather, and the spermatophora, with their fertilizing contents are finally conveyed *in coitu* to the proper "vesicula seminalis," or "spermatheca," which, as a general rule in hexapod insects, belongs to the female.

As a general rule, the life of an insect soon ends after the great act of impregnation has been fulfilled. The change of form prior to the acquisition of the procreating power is usually extreme, and rapidly undergone; the ordinary every-day life of the insect, spent in acquiring and consuming its daily food, forms a far larger proportion of its existence, and is passed under a very different and a very inferior form; which, if, in comparison to the last stage, we should regard as the more typical form of the animal, we shall not probably err. The cock-chaffer passes three years as a subterranean worm, but lives hardly as many months in its winged state. An ordinary observer sees and knows the May-fly only in that last joyous stage of its existence, and deems its life concentrated in one winged nuptial holiday; but, this so-called *Ephemera* has previously passed three hundred and more working days as an aquatic larva.

In no class of animals are the parts of generation so complex as in insects. The female sexual organs consist of the ovaries, the oviducts, the uterus, the spermatheca, the bursa copulatrix, the mucous glands, or colleteria, the scent-glands, and vagina; but, these are not all present in all insects. The external organs are the vulva, the sting, the holders, and ovipositor, some of which are likewise peculiar to particular species.

The most constant and essential parts of generation of the female insect, viz., the ovaria, are subject to almost as many varieties as the testes in the male; their forms may be arranged into almost as many genera and species, which are very often analogous to those of the essential glands in the opposite sex. The ovaria in the Lepidoptera do not, however, coalesce into a single mass, like the testes in the male; they are either digitate or verticillate; that is to say, they consist of a few egg-tubes suspended to the end of the oviduct, becoming attenuated as they recede from it; or they consist of numerous very long egg-tubes, proceeding from a short oviduct, and terminating in filiform extremities; they are usually disposed in spiral coils bending at the two sides in opposite directions, as in the *Noctua Brassicæ*. In the forest-fly each ovarium consists of two egg-tubes; in the flesh-fly it consists of a single tube, which is of great length, and twisted spirally. In the mantis a single series of short egg-tubes are attached to one side of a common duct. In the gnats, crickets, and locusts, the numerous egg-tubes, which are somewhat compressed, lie upon one another like scales, or the tiles upon a roof. In the Ephemera and Stratiomys, the ovaries have the primitive form of simple elongated bags, in which the eggs are contained linked together by delicate filaments.

Swammerdam has given an accurate description, with excellent figures of the female organs of the louse, the discovery of which helped him to an excellent argument against the spontaneous generation of that parasite from the filth of the abject members of our species, which it commonly infests. Five egg-tubes converge and coalesce into a single short oviduct on each side; the two unite into a common tube, with which a pair of branched accessory follicles communicate. The vulva is surrounded by four mammillary eminences; the spermatheca and bursa copulatrix are wanting.

In most *Diptera* the ovaria consist of numerous short egg-tubes, each divided into three or four compartments or egg-cells: the egg-tubes are variously disposed, combined, and associated in the different species. The sperm reservoir is present; it is generally trifid, rarely bifid, as *e. g.* in this *Stomoxis* (showing the dissection) still more rarely simple, as in *Pulex*.

There is no *bursa copulatrix;* but beneath the sperm-reservoir, in the common fly, the vagina swells out into a cordiform cavity, which receives the impregnated ova, and in which they are deve-

loped in the larviparous genera, *e. g.*, *Musca*, *Anthomyia*, *Sarcophaga*, *Sachina*, and *Dexia*.

In the great forest-fly (*Hippobosca*), the ovaria are each a small simple cœcum, opening into a short common oviduct, which swells out a little above the communication. A pair of small sperm-reservoirs next open into the oviduct, and afterwards the ducts of two ramified colleteria; the part answering to vagina, swells out below this into a uterus, in which the ova are developed, and the larva metamorphosed, in this pupiparous insect.

In the *Lepidoptera*, the ovaria consist of four pairs of egg-tubes, disposed as I have already described. The sperm-reservoir is pyriform, and generally provided with a long spiral *ductus seminalis*, in whose basis a sometimes simple, sometimes bifurcate glandular cœcum opens. The colleteria are situated below, and consist of a pair of convoluted cœca, swelling out into pyriform receptacles at the vagina, where they open by a common duct.

In some butterflies, two small branched glandular organs are superadded, called the "scent-glands;" they secrete the peculiar odorous particles that attract the males; and of which property the entomologist sometimes avails himself in catching the finest specimens of that sex.

The bursa copulatrix finally presents a remarkable development, being a capacious pyriform, sometimes hour-glass-shaped, reservoir, which is furnished with a peculiar intussusceptive canal opening outwardly beneath the vulva. This latter canal gives off, by the way, a narrow convoluted lateral canal, which opens into the vagina near the orifice of the spermatheca, and thus effects the communication between the copulative sac and that reservoir.

Experiment has proved the office of the spermatheca to be that which its name implies. By the application of the fluid contained in it to the eggs of an unimpregnated female, Hunter made them fruitful: he also found that the intromittent organ penetrated its canal,—an observation which has since been confirmed by Audouin, and other observers.

In the hymenoptera the ovaria present great diversity as to the number of the egg-tubes, which varies from 3 or 4 in the humble-bee, to 6 in the wasp, to 10 in *Pimpla*, up to more than 100 in the queen-bee. To the short canal of the sperm-reservoir there are always attached tubular and glandular appendages, which usually bifurcate, and open into the duct of the reservoir. There is no bursa copulatrix in the hymenoptera. The colleterium is metamorphosed into the poison bag and glands, unless, indeed, we may view the appendages to the sperm-reservoir as homologues, and not merely as analogues, of the colleteria in other insects.

With regard to the hemipterous modifications of the female organs, I shall refer, as in the case of the male organs, to the *Aphis*.

The two kinds of fertile females of this remarkable genus present two modifications of the female organs.

The viviparous females have two ovaria, from each of these, four multilocular oviducts are continued. The vagina is devoid of all appendages. The eight oviducts are similar in size, and the embryo is contained in the lowest or hindmost chamber.

The oviparous females have, also, two ovaria with eight oviducts, divided into two chambers each. The oviducts are seen in the most different stages of development, so that usually not one of the eight resembles another. In the fullest developed tube, the last chamber is capacious, large, and oval; the upper one small and conical. In the undeveloped state the whole tube forms only a simple pyriform swelling of the oviduct, from which the upper conical compartment is by degrees established. The lower chamber contains a finely granular mass, which is gradually transformed into an oval egg; the upper chamber is full of cells, containing smaller nucleated cells. If we regard these nucleated cells ars germ cells, we may conclude that more than eight eggs are laid. Near the outlet of the vagina are two short cœca with thick walls, which contain a colourless, oil-like mass. A little before these the spermatheca opens; it is a colourless pyriform appendix to the vagina, and is of so delicate a structure as to be readily overlooked when it is empty, but it is filled with the spermatozoa after the coitus. The spermatheca is not so crowded, as in many other insects, with the spermatozoa, and hence their marvellous vibratory and undulatory movements may be witnessed.

The ova are fertilized during their passage along the vagina by the spermatozoa, and are smeared with the viscous secretion of the "colleteria," called *glandes sébifiques* by Léon Dufour. From the different organization of the internal generative organs of the oviparous and viviparous female *Aphides*, it follows that the first cannot ever bring forth living young; and that when once this oviparous generation is produced, no external circumstances, *e. g.*, warmth, can convert the individuals of such generation into viviparous females.

The males are frequently seen *in coitu* with the oviparous females, and the embrace is so close, that when seized by his wings the female is raised along with him. The males seem to be much fewer in number than the oviparous females; yet Siebold detected in all that he examined spermatozoa in the spermatheca, and thence concludes that the Aphides are polygamous; to which the structure of the male organs offers no physical impediment, as in *Lepidoptera* and *Coleoptera*.

In the *Orthoptera*, the ovarian tubes are commonly numerous and multilocular. The sperm reservoir communicates with the vagina by a short neck in *Locusta*, and by a longer canal in *Acheta*. There is no "bursa copulatrix;" and the colleteria are likewise wanting in *Parficula*, *Phasma*, and the *Acrididæ*, but they exist in the genus *Locusta*, and are complex and ramified in the cockroach, where they have to provide the materials for the complex egg-case.

The ovarium presents two types of structure in the *Coleoptera*, the flagelliform and the sacciform; in the former type, there may be either three or six egg-tubes in each ovarium, according to the species. The sacciform type is presented in the darkling beetles (*Meloe*), and the ovarium is remarkable for the imbricated arrangement of its countless egg-capsules. The sperm reservoir is claviform in *Scarabœus*, or is bent upon itself, with a long neck, communicating with the vagina, or with the copulative pouch. Usually a simple, sometimes a bifid (rarely a ramified) accessory mucous gland opens into the base of the sperm-reservoir. There are no true colleteria; and I may remark that these organs are likewise absent in the Neuropterous May-flies (*Ephemera*) and Dragon-flies (*Libellula*).

The vulva is a complex aperture in most insects, and is defended by an upper and two lateral valves or plates; it is usually accompanied by other modifications or appendages of the terminal segments for grasping the penis and for oviposition.

Certain social Hymenoptera, which, as John Hunter quaintly observes, "have property to defend," possess a peculiar poison apparatus, which is essentially a modification of these accessory parts of the female organs, which are the only parts that acquire a functional activity in the neuters of the bee and wasp. The poison is secreted by two long and slender ducts—the homologues of the "colleteria," which unite together and empty their secretion into an oblong bag, which discharges itself by a narrow duct between the valves of the sting. This is a long, slender, and sharp process, with a serrated edge, which generally prevents its retraction when thust into the skin; it is the homologue of the "ovipositor:" the protecting valves are modifications of the last abdominal segment.

The corresponding parts are variously modified in other insects to insure a proper deposition of the eggs. In some insects, as the *Locusta viridissima*, the bivalve ovipositor is longer than the body, and, by means of it, the ova are conveyed to the proper depth in the soil, the act of oviposition being precisely analogous to that of setting seeds in the earth. In the saw-flies, the main part of the ovipositor is long, slender, and serrated, like the sting in the bees. With this instrument the female saw-fly (*Tenthredo*) saws into the substance of leaves, and there insinuates her eggs. The Ichneumons have a similar apparatus, but extremely elongated and slender, by means of which they introduce their ova beneath the skin of other insects.

Insects, like crustaceans, are occasionally subject to one-sided or dimidiate hermaphroditism. Numerous instances of this kind are given by Ochsenheimer. In fourteen of the instances which he cites, the right side was male and the left female; in nine instances it was the reverse. Occasionally hermaphrodites are found, where the characters of one sex, instead of extending over one-half, are limited to particular parts of the body, which agrees in the main with the other sex. Thus an individual of the *Gastrophaga Quercus* has been observed, in which the body, the antennæ, and the left wings were those of the famale, the right wings those of the male. The external sexual characters are very striking and various in the class of insects, and readily lead to the detection of the hermaphroditical condition of the internal organs.

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and Comparative Anatomy" in the Museum of the Royal College of Surgeons, which occupies five

was marked by many bitter controversies which one would rather not recall. Considering the long period

of the varying reception ex-

formally sanctioned by a Bill. Still, the Ministry is not supposed to be stable. On Monday the Premier had to announce that the Bill regulating the banks of issue would be postponed for three months pending further inquiries; and there are grave rumours that there have been irregularities in the management of these banks. "Our Panamino"—the little Panama scandal—as this matter is termed by one journal, may have serious consequences for the Ministry. A Parliamentary inquiry into it has been decided on. Signor Crispi abstained on Friday week with his followers, and many of the Right. Signor Nicotera's party spoke against the Ministry and voted for it provisionally.

The scheme of reform of the Bulgarian Constitution has passed the Sobranje by a large majority. There will be a general election next month.

Last week it was announced that a plot had been discovered to poison the non-unionist workmen at the Carnegie works at Homestead, Pennsylvania. Two thousand men are said to have been ill. This week some arrests have been made and true bills found, and similar attempts are reported from Nova Scotia and Arkansas—the victims in both the latter cases being convict labourers, whose employment under lease to contractors (we do not know if this is so in Nova Scotia) is one of the blots on the civilisation of some of the American States. The affair recalls the proposals to poison wells and distribute infected clothing through the post made by irresponsible persons in the South during the War of Secession.

PROFESSOR OWEN.

IN the calm and peaceful retirement of Sheen Lodge, Richmond Park, there has passed away, in his 89th year, Professor Sir Richard Owen, K.C.B., the most celebrated comparative anatomist and palæontologist of this century—a man whose life has been almost incessantly occupied in one pursuit, the study and description of the recent and fossil remains of vertebrate animals, and whose greatest public service has been the acquisition, through his persistent importunity, of the magnificent building in Cromwell Road, in which are now preserved the entire series of Natural History collections, formerly so inadequately housed in the old British Museum in Bloomsbury.

Professor Owen has occupied so prominent a figure in the world of science, and has been so frequently interviewed and written about, especially during the past thirty years, that it seems hardly possible to say anything with which the reader is not already familiar. Few, however, are aware that in early youth he served as midshipman on board H.M.S. *Tribune;* but the close of the American war, in 1814, effectually precluded all chances of promotion in the Navy, and the youthful middy returned to school on shore, and subsequently studied medicine with Mr. Baxendale, in his native town of Lancaster, matriculating in the University of Edinburgh in 1824. Two years later he obtained the diploma of the Royal College of Surgeons in London, and acted as dissector at St. Bartholomew's Hospital, under the famous Dr. Abernethy, who quickly recognised his rising talent. He spent some time in attending the École de Médecine in Paris, where he listened to the lectures of the illustrious Cuvier, whose labours in fossil osteology he has so closely followed up. In 1827 he commenced a private practice as a surgeon in Serle Street, Lincoln's Inn Fields. Shortly afterwards he was appointed, on the recommendation of Abernethy, to be Assistant-Curator of the Hunterian Collections. From this time he devoted himself to the pursuit of comparative anatomy, and set to work diligently to prepare a "Descriptive and Illustrated Catalogue of the Specimens of Physiology and Comparative Anatomy" in the Museum of the Royal College of Surgeons, which occupies five quarto volumes. He also prepared the catalogues of Natural History, Osteology, and of Fossil Organic Remains, preserved in the same museum. For many years Owen acted as honorary prosector to the Zoological Society, dissecting the various rare animals which from time to time died in its menagerie, and communicating the results of his studies at its evening meetings.

In 1834 Professor Owen was appointed to the Chair of Comparative Anatomy in St. Bartholomew's Hospital, and married, in 1835, the daughter of Mr. William Clift, Curator of the Hunterian Museum. In the same year he was appointed Hunterian Professor and Conservator of the Museum of the Royal College of Surgeons, and in 1836 he was elected a Fellow of the Royal Society. Professor Owen also held the Lectureship of Anatomy and Physiology in the College of Surgeons, and continued to lecture there down to the year 1855.

He published his great work on "Odontography," or comparative studies of the structure of the teeth of animals, in 1840-45, in two large quarto volumes. His memoir on the "Pearly Nautilus" appeared in 1832, and that on the Belemnite from the Oxford clay, printed in the Philosophical Transactions, which was honoured by the Royal Society with the award of one of the Royal medals in 1846.

Professor Owen was elected President of the British Association in 1857, and presided over Section (D) Zoology, at the Jubilee meeting at York, in 1881.

In 1856 a new interest was given to Owen's career in the scientific world through his appointment by the Queen to the post of Superintendent of the Departments of Natural History in the British Museum—a position which he held until his retirement from public life at the age of eighty on the 31st December, 1883. From the date of his accepting office to the year 1880, Owen's most earnest desire, outside his regular scientific work, was to secure for the Natural History collections suitable gallery-space and proper accommodation for the valuable but overcrowded objects which the British Museum contained. He speedily perceived that in all administrative matters he was but a child beside Mr. Panizzi, the Principal Librarian and actual head of the whole Museum, and felt that his only chance of fair play for the Natural History section was in advocating its removal to a new site. This one subject—"the inadequate accommodation at present afforded to the Natural History collections"—was the text of Professor Owen's reports to the Trustees, of his lectures, his pamphlets, and his various newspaper articles for twenty years. No doubt the principal support which he received was from the Prince Consort, and in Parliament from the late Lord Palmerston and the present Prime Minister, Mr. Gladstone; but his first essay, in May, 1862, proved a failure, the attempt to bring in a Bill to authorise the removal of a part of the Trustees' collections in the British Museum being thrown out by a majority of ninety-two votes. In 1863 a second effort was made, the Government asking authority to purchase five acres at South Kensington for a Natural History Museum, which was carried, after a long debate, by a majority of 132 votes. But it was not until 1871 that the first grant of £40,000 was voted for the erection of the building which in 1880 was completed and formally handed over to the Trustees.

Professor Owen had the happiness to see this great work accomplished, but, although allowed to enter his "Promised Land," he was not permitted to remain, but was retired in 1883, being succeeded by Professor (now Sir W. H.) Flower. On his retirement the Queen conferred upon him the honour of Knight Companion of the Bath, but his best recognised title will ever be that of plain "Professor Owen."

Much has been said and written by his opponents to the disparagement of Owen's work, and indeed it cannot be denied that his career as a scientific man was marked by many bitter controversies which one would rather not recall. Considering the long period

—of more than fifty years—over which that work extended, it need hardly surprise one to learn that many of Owen's conclusions have since been controverted. But when we reflect that he was a naturalist of the pre-Darwinian epoch, and that the very methods of modern biological research, as now followed, have been introduced since his chief work was accomplished, we shall the more readily understand that the younger school of naturalists have little sympathy with the men of his time. A vast amount of his labour was devoted to descriptive palæontology and zoology—chiefly of the vertebrata—although, as already mentioned, his earlier laurels were won in invertebrate researches. His chief works have reference to the extinct Birds of New Zealand, but he has also written memoirs on the Dodo, the *Archæopteryx*, the *Dasornis*, and other fossil birds. The extinct Marsupial fauna of Australia and the gigantic Edentata of South America have each claimed many years of his life; he has also described the singular Triassic Reptilia of South Africa, some of which, in their dentition, offer so remarkable an approach to warm-blooded mammals. Of British fossil reptiles he has written most largely, as witness his voluminous contributions in the long array of volumes published by the Palæontographical Society, of which he was the perpetual President.

Newspaper writers, who deal in the marvellous, love to attribute to Owen the miraculous power of building up entire extinct animals from a *tooth* or a *claw*: one even wrote, not long since, "Show him a splinter of an egg-shell and lo! the *Dinornis*." That he once prophesied, from the examination of the broken shaft of a bird's femur found in New Zealand, that large ostrich-like birds would be discovered in that island before any other evidence was forthcoming, is quite true; but all his determinations were based on most careful and patient study and *comparison* with both recent and fossil bones, and he never made a statement without he had pretty full evidence in support of it, being far too cautious to make guesses.

By his unwearied powers of work, Owen kept up, for nearly forty years, a continuous series of papers and monographs, contributed to the Royal, Zoological, Geological, Linnæan, and other Societies, including the British Association and the Palæontographical Society.

If it should be asked what led to Owen's popularity, it would at first sight be difficult to say; one would hardly describe his most popular attempts at writing as amusing or entertaining, although we readily grant they are most instructive. As a lecturer he was certainly successful, carrying his audience with him thoroughly; yet when he once *read* a discourse at the Royal Institution, on Museums, he wearied out his audience, and persisted in exceeding the time-limit by three-quarters of an hour! His *viva-voce* demonstrations and lectures were, however, always most interesting, and attracted very large audiences. He made such a favourable impression upon the Prince Consort that he was frequently requested to lecture upon Natural History subjects before the Queen and Royal Family at Buckingham Palace and at Windsor Castle.

Professor Owen cultivated a courtly and polished manner; but perhaps his most successful *rôle* was that of a conversationalist at the dinner-table, when he had an endless series of anecdotes to retail, chiefly of the illustrious persons he had met and of the places he had visited. His greatest pleasure was to relate his two winters' experiences in Egypt, one of which was spent in attendance on the Prince and Princess of Wales. Although so immersed in his scientific work, Owen had the happy knack of being able to lay aside his studies and enter into the pursuits of others, even those of children, with whom he was always a favourite. He was a good musician; he delighted to take part in a quartette, and could play upon the violin with great skill. His friend, Dr. Arthur Farre, and his late colleague, Mr. George R. Waterhouse, were frequently his fellow-performers at these musical reunions, whilst Mrs. Waterhouse presided at the pianoforte.

His strikingly tall figure and antiquated attire—always a marked feature at scientific gatherings—will not easily be forgotten, and *Punch*, *Vanity Fair*, and other contemporary papers, have fortunately embalmed them for history. The original plaster-model (from which Hamo Thornycroft executed a marble bust for one of Owen's friends) is preserved at the east end of the Geological Gallery of the Natural History Museum, where it stands amidst the evidences of the Professor's greatest palæontological triumphs—the *Dinornis*, the *Megatherium*, and the *Diprotodon*.

Many circumstances contributed to bring about the success which crowned Professor Owen's lifelong labours. He graduated in medicine, and in early life practised as an ordinary member of his profession. This his brother-practitioners never forgot, and on all occasions they rallied round him and gave Owen their support.

His palæontological work was carried on at a time when public interest was first aroused in the study of geology by the writings of Lyell and the lectures of Buckland and Sedgwick, whilst Mantell, Agassiz, Egerton, and Enniskillen were his contemporaries. At that time Owen stood almost alone as the exponent of vertebrate palæontology, and in his anatomical researches in zoology also. Through the medical profession he entered the Royal College of Surgeons Museum and became Hunterian Professor. By the Queen's favour he was made Superintendent of the Natural History Departments of the British Museum.

He was a great student, an earnest worker, a keen disputant on scientific matters, but a feeble administrator, leaving official matters to be carried through entirely by his subordinates, and in all public matters trusting to his friends in power, who certainly helped him most generously. For many years he enjoyed a Civil List pension from the Queen, as well as the residence he occupied at Sheen, Richmond Park. Of honours he had no lack. From the Royal Society he received the Royal and Copley Medals; from the Geological, the Wollaston Medal; from the Linnæan Society, a special medal. He was a Member of the Institute of France; honorary member of nearly every scientific society at home and abroad; and held honorary degrees from the Universities of Oxford, Cambridge, and Edinburgh. The late Emperor of the French conferred upon him the Legion of Honour; the Emperor of Germany, the Order of Merit; the King of Italy, the Order of St. Maurice and Lazare; the late Emperor of Brazil, the Order of the Rose. He was also decorated by the King of the Belgians.

Much has been said of the mistakes which Owen made; but it may fairly be asserted that so colossal a life-work will outlive all detractions, and his name will be handed down to posterity with that of our greatest scientific men of the Victorian epoch.

THE UNCONSCIOUS VILLAIN.

MR. BERNARD SHAW has been defending his play against the critics with his usual facility of ingenious paradox. He has presented in *Widowers' Houses* a certain view of society, and he argues that all objections to his work from an artistic standpoint proceed from a state of mind which "lacks conviction of sin." The critics looked into the mirror which Mr. Shaw held up to nature, and then straightway forgot what manner of men they were. They said, "This character is false, and that is overdrawn," and Mr. Shaw rejoins: "But what about the label on your match-box, and the shirt you are complacently wearing without a thought that it may have been stitched by some poor wretch who has to eke out a miserable pittance

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MEMORIAL TO SIR RICHARD OWEN.

SPEECH BY THE PRINCE OF WALES.

His Royal Highness the Prince of Wales presided on Saturday over a numerous and influential meeting of ladies and gentlemen, held in the rooms of the Royal Society, Burlington House, for the purpose of commemorating by some suitable Memorial the scientific services of the late Sir Richard Owen. His Royal Highness was accompanied by the Duke of Teck, and among those also present were Lord Kelvin, Lord Playfair, the Bishop of Rochester, Professor Huxley, the Dean of Westminster, Sir Henry Roscoe, M.P., Sir James Paget, Sir Henry Thompson, Sir Frederick Leighton, Sir George Stokes, Sir Archibald Geikie, Sir Henry Acland, Sir Joseph Lister, Sir Spencer Wells, Sir Frederick Bramwell, Sir John Evans, Sir John Fowler, Sir William H. Flower, Lady Flower, and Miss Flower, Sir G. and Lady White Cooper, Sir George Humphry, Sir Thomas Storey, Sir Thomas Crawford, Mrs. Lyell, Mr. and Mrs. W. P. Sladen, Sir D. Campbell, Sir E. Saunders, Miss Sulivan, Mrs. Dawbarn, Admiral Sir E. Ommanney, Lady Smythe, the Rev. R. Owen and Mrs. Owen, Sir F. Abel, Sir Andrew Clark, Dr. Jonathan Hutchinson, Mr. Thomas Bryant (President of the Royal College of Surgeons), Mr. Holman Hunt, Dr. E. Maunde Thompson, Dr. Albert Günther, Mr. Wilson Noble, M.P., Professor Michael Foster, Dr. Edward and Mrs. Frankland, Professor F. Jeffrey Bell, Dr. R. Hingston Fox, Dr. E. A. Bond, Dr. Thorne Thorne, Mr. Albert Chancellor, Mr. E. Beresford Chancellor, the Rev. Professor T. Wiltshire, Dr. H. Woodward, Dr. Braxton Hicks, and Mr. P. L. Sclater (Secretary of the Zoological Society).

The Prince of WALES, who was received with cheers, said—Ladies and Gentlemen: I have had the great privilege conferred upon me of being asked to take the chair to-day on a very special occasion. We are assembled together for the purpose of paying a mark—a tribute—of respect and appreciation to the memory of a great man of science who has lately passed away from us. The name of Sir Richard Owen must go down to posterity as that of a great man, one who was eminent in the sciences of anatomy, zoology, and palæontology. (Cheers.) Perhaps I may be allowed to say a word of my own personal knowledge of him. It is now 35 years since I had the advantage of knowing him when I lived as a boy in the White Lodge, Richmond-park, now occupied by my illustrious relative on my right (the Duke of Teck). I had frequent opportunities of visiting him and of knowing him. His geniality, his charm of manner to all those who knew him, will, I am sure, have left a deep and lasting impression. Whether he was explaining to you the mysteries of some old fossil bone that had been given him, or whether he was telling one of his vivid ghost stories, one felt that one was under the charm of his presence. (Cheers.) His method of teaching, as you all know, ladies and gentlemen, was earnest and clear in every respect, and it even gained a certain force when he had a certain hesitation in his manner. His great repute as a zoologist in the study not only of living animals, but of those long extinct, followed the same large range of work as Cuvier, of whom, in the history of science, he may be regarded as the successor. One of the great works and interests of his life was the formation of the Natural History Museum, which is now safely established at South Kensington under the able guidance of our friend Sir William Flower. (Cheers.) Within your recollection will be the very great difficulties that Sir Richard Owen encountered when he was first appointed superintendent of the departments of the Natural History Museum at the British Museum, Bloomsbury. He himself saw on taking that appointment in 1856 that it was quite impossible that those large collections could be adequately seen, unless they were removed to some other sphere. In 1862 a Bill was brought in by Mr. Gladstone, who took the greatest interest in the matter, but it was vigorously opposed, strange to say, by no less a great man than Mr. Disraeli, and the Bill was lost, though eventually, 10 years later, it was carried, and now we have that very fine building which all of you, I am sure, know and deeply appreciate. (Cheers.) I may also mention that Sir Richard Owen took the greatest interest in the Colonies, and in trying to obtain from them specimens by which they might be worthily represented in the Natural History Museum. In sanitary matters, also, he was not behindhand, and we all know of his long intimacy with that distinguished man who has also passed from us, Sir Edwin Chadwick. Ladies and gentlemen, there are several resolutions to be proposed, and you will hear far better and more eloquent remarks from many distinguished gentlemen, who will move and second them, and that is the reason why on this occasion I do not intend to trouble you with any more remarks. Allow me only to repeat the assurance of the deep interest that I take in this movement to secure a suitable Memorial to the memory of this great man, and how deeply I appreciate having been asked to take the chair on this most interesting and important occasion. (Cheers.)

Lord KELVIN moved—"That it is desirable that the eminent services of the late Sir Richard Owen in the advancement of the knowledge of the sciences of anatomy, zoology, and palæontology, should be commemorated by some suitable Memorial." His Royal Highness, he said, had told them of the strenuous efforts made by Professor Owen to obtain the formation of a Museum of Natural History, the Museum in Bloomsbury having been found utterly inadequate for the display of the specimens so as to allow them to be really useful. If for no other reason than the part Owen took in the establishment of the Natural History Museum, and the success which ultimately attended his efforts, he was deserving of their gratitude. (Cheers.) No fewer than 360 papers, every one of them valuable, were to be found under Richard Owen's name in the Royal Society's catalogue of scientific papers. Every subject of the Queen, whether in these islands or the British Colonies, and every stranger who visited England must feel the benefit of being allowed to go into that splendid Museum of Natural History at South Kensington. (Cheers.)

Professor HUXLEY, who seconded the resolution, said that any fitness which might lie in him for the performance of the task was probably due to the fact that, if he mistook not, there were very few men in England who had had occasion to pursue the work of the remarkable man whose career they had met to celebrate with more carefulness and attention than he had. It was a career remarkable for its length, for the rapid rise to eminence, and the long retention of high position of the person who was the subject of it. It was more than 40 years ago since he, as a young man, had occasion to look abroad upon the scientific world of London, in which he was then a complete novice, to see whether perhaps some small and insignificant corner of it might be found for him. At that time there were four persons whose names stood out amongst the first galaxy of scientific men of the century. They were Sir John Herschel, Mr. Faraday, Sir Charles Lyell, and lastly, though by no means least, the famous Hunterian professor, Richard Owen. When he cast his eyes abroad the same eminent position attached to Owen, who, whether for extent or thoroughness or variety of work, held his place fully among all. Many regarded him as the successor and continuator of Cuvier. That was perfectly true. Nowhere else except in his work did they find, so far as he knew, memoirs like that on the pearly nautilus, like that on the marsupials, like that on the apteryx, which were fit to be put on the same level as the famous monographs by which Cuvier instituted the modern science of comparative anatomy, and if Owen was the man on whom, more than any other, the mantle of Cuvier had fallen, another side of his work showed him as the continuator of, and successor to, that school to which Cuvier was most energetically and, he might say, bitterly opposed—he meant the school of St. Hilaire. He rejoiced in this movement to preserve the memory of the great work achieved by stupendous powers of acquisition, wonderful sagacity in interpretation, and untiring strivings in the cause of science. (Cheers.)

The resolution, on being put by his ROYAL HIGHNESS, was carried unanimously.

The Duke of TECK, who was received with cheers, said—Your Royal Highness, Ladies, and Gentlemen,—I am to propose "That the Memorial shall consist primarily of a marble statue to be placed in the hall of the Natural History Museum." There is no doubt, to my mind at least, that this would be the most appropriate place and the most appropriate form in which to erect the likeness of our admired friend. It is, so to say, his second home, the home of his labours, and no better place could be found. Besides, I think it is a very nice idea that everyone who enters the hall should see first of all the man to whom we owe this inheritance. (Cheers.) As others have said so much about Sir Richard Owen, it is impossible for me to go over the ground again. As all of us know so well, what he has been and what he has done will remain in the mind of everybody who survives him, and, therefore, I will only say that in my opinion the hall, which is a very fine interior, of the Natural History Museum, should be the place where the Memorial of this great man should be erected. (Cheers.)

Sir W. FLOWER, in seconding the resolution, said that, having had twice in his life to succeed Sir Richard Owen in the offices he held, and having had great opportunities of judging of his character and work, it might have been necessary for him to say some words about the general character of that work had he not been relieved of the responsibility by the introductory remarks of his Royal Highness and the observations of one more competent than any man in the Kingdom to give an opinion on those scientific services—Professor Huxley. Sir Richard Owen, as they all knew, did an enormous amount of work. His activity and energy were something marvellous, and the enormous number of papers which he wrote, extending over a period of nearly 60 years, embraced almost every subject connected with zoology and palæontology. (Cheers.)

After a few words from Mr. P. L. SCLATER, the resolution was adopted.

Sir JAMES PAGET moved, "That a committee be formed to carry out the preceding resolutions." It would be impossible to have any better evidence that the resolutions just passed were right than the number and position of those who had offered to serve on the committee, for there was never a more representative list of any kind. Headed by the Prince of Wales, the Duke of Teck, the Archbishop of Canterbury, and the Lord Chancellor, it contained nearly 150 of the most prominent workers in all branches of science and many who were the best judges of the influence of science on the general wellbeing of the nation. He had known Professor Owen for nearly 60 years. It was in 1834, when he entered as a pupil at St. Bartholomew's Hospital, that he first knew Owen and was able to observe something of his influence upon men of science. The whole country might be proud in having had him as one who appreciated the value of these museums as a means of study. (Cheers.)

The resolution was seconded by Sir JOHN EVANS, and unanimously passed.

Sir ANDREW CLARK moved, "That the following list of gentlemen constitute the Executive Committee:—His Royal Highness the Prince of Wales (Chairman); his Serene Highness the Duke of Teck, the President of the Royal Society, the President of the Royal College of Physicians, the President of the Royal College of Surgeons, the President of the Linnean Society, the President of the Zoological Society (treasurer); Sir John Evans, Professor Michael Foster, Dr. A. Gunther, Professor Huxley, Sir F. Leighton, Sir James Paget, Mr. P. L. Sclater, Mr. W. Percy Sladen (secretary), Lord Walsingham, Mr. A. Waterhouse, R.A., and Mr. Henry Woodward." England sometimes forgot to recognise the truth that nations, like individuals, could not live by bread alone. It was very true that commercial enterprise, the increase of peoples, the circulation of money, the exchange of commodities, and a good understanding between capital and labour were essential to the material prosperity of a nation; but such material prosperity was not the true and abiding life of a nation. Ideas, too, were necessary. (Cheers.) All men who set their fellows upon fresh trains of thought and stirred them to new courses of action were great benefactors—and surely Richard Owen had done this. (Cheers.)

Mr. T. BRYANT, who seconded the motion, said that all who had attended Owen's lectures felt very keenly his force and his power.

Lord PLAYFAIR, speaking in support of the resolution, referred to Sir Richard Owen's services in the cause of sanitary science, and said that he desired to testify, from personal knowledge, to his breadth of cultivation.

The resolution was carried unanimously.

Sir W. FLOWER announced donations to the amount of about £250, headed by £25 from the Prince of Wales.

Sir HENRY ACLAND moved, Professor MICHAEL FOSTER seconded, and the meeting adopted the following resolution:—"That the cordial thanks of this meeting be given to his Royal Highness the Prince of Wales for consenting to become Chairman of the Committee, and for presiding on the present occasion."

The Prince of WALES, in acknowledgment, said:—Ladies and gentlemen, I beg to return my warmest thanks to my kind and valued old friend, Sir Henry Acland, for the manner in which he has proposed, to Mr. Michael Foster for the way in which he has seconded, and to you all for the kind manner in which you have received, this resolution. It has, indeed, been a labour of love to me to-day to preside on this very interesting occasion, and I think that it has seldom been my good fortune to listen to more interesting or eloquent addresses than those which have fallen from the lips of the eminent gentlemen who have spoken. No one will take a deeper interest in the carrying out of this Memorial to our lamented friend, Sir Richard Owen, than myself, and most sincerely do I hope that the great work that is to adorn the Natural History Museum will be worthy of a great sculptor and of the great man that it represents. (Cheers.)

The proceedings then closed.

HUNTERIAN LECTURES

ON THE

GENERATION AND DEVELOPMENT OF THE INVERTEBRATED ANIMALS.

By RICHARD OWEN, F.R.S.

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[*Reported expressly for the Medical Times, and revised by the Lecturer.*]

LECTURE XVI.

GENERATION OF INSECTS.—Development of the ova; virgin generation of the aphides: its true conditions and analogies explained—Supposed parthenogenesis of the *Psyche* explained by the peculiarities of their impregnation—Various forms and appendages of the ova of insects—Cocoons and other nidi—Oviparous, larviparous, and pupiparous insects—Striking evidence of design in the instincts of oviposition—Development of the embryo: various grades of this at which it quits the ovum.

MR. PRESIDENT AND GENTLEMEN,—So far as regards the organic machinery for propagation, that mechanism has reached its highest grade of complexity in the class of insects. In the male individuals we have found "testes," "epididymys," "vasa deferentia," "vesiculæ seminales," "prostates," "penis," and "claspers:" with a hundredfold variety in the forms and proportions of the several parts. In the female individual we have seen, besides the ovaria and oviducts, special enlargements of the latter, to which the name of "uterus" might be applied, seeing that in certain insects the embryo was developed therein; and the vagina was complicated with a spermatheca, bursa copulatrix, colleteria, vulva, ovipositor, and copula. As might be expected from the very common form of the ovaria, as long and slender tubes, they offer peculiar facilities for tracing the development of the ovum as such. Professor Wagner has ably availed himself of this peculiarity in tracing out the progressive steps in the formation of the ovum, and has given good descriptions of the process in his work, entitled, "Beiträge zur Geschichte der Zeugung und Entwickelung," illustrated by figures of the parts, and the progressive stages of the ovum in the female dragon-fly (*Agrion virgo*.) The germs of the ova first appear in the capillary beginning of the ovarian tube as a single file of minute elliptical granules or nuclei: as the tube expands the cell-wall appears surrounding the first part, and the ovum is now in the condition of a minute pellucid vesicle, having a central nucleus. Such nuclei and nucleated cells make their appearance in the capillary beginnings of the ovarian tubes, where they are drawn out to microscopic tenuity. From these extremities the ova successively pass into the wider part of the tubes, and in this course increase in size by the expansion of the nucleus, and by the multiplication of vitelline granules around the primitive cell: at first the ova are separated from each other by an amorphous granular substance of equal size, which is called a placentula, but lower down by mere constrictions of the ovarian tube. Here the ova acquire a distinct vitelline membrane, and then, continuing to increase in bulk by the addition of vitelline matter, they reach the converging end of the ovarian tubes, and enter the shorter and wider oviduct. Here they receive additions to their external surface from the secretions of the colleterial organs, and admit into their interior the mysterious principle of the male fluid, which would seem to be assimilated into their substance, more especially into that of the central nucleated germ-cell.

It is essential to the development of the embryo, that the germ-cell receive the matter of the spermatozoon; the ovum is then said to be impregnated.

The phenomena that thence ensue are essentially the same up to a certain point in all animals, and consist in the propagation on the part of the impregnated germ-cell, by a series of reiterated spontaneous divisions, of a numerous offspring. The right and clear comprehension of the purpose of this process, or the object effected by it, is essential, as I have already endeavoured to show, to the elucidation of the nature and relations of the subsequent modifications and varieties in the course of development. The progeny of the primary impregnated germ-cell are the "secondary or derivative germ-cells," and the whole is the "germ-mass."

The progeny of the impregnated germ-cell resemble their parent in all respects, save that they show a diminution of size. When they cease to exist as germ-cells, either by coalescing with others or by liquefaction, they do not lose their vitality; as individuals, indeed, they may be said to die, but by their death they minister to the life of a being higher than themselves; they combine to construct its tissues, or dissolve and impart properties to its fluids; these metamorphoses being mysteriously governed by a plastic nature or mode of force operating unconsciously upon the matter; but, according to a law of order and harmony, and directed to a fore-ordained and definite end, resulting in a distinct and specific form of animal, adapted by its organization for a particular sphere of existence, and forming a more or less valuable, but not, as once was thought, an essential link in the great chain of organic life.

It is important, however, to bear in mind, that not all the progeny of the primary impregnated germ-cell are required for the formation of the body in all animals; certain of the secondary germ-cells, or their nuclei, may remain unchanged, and become included in that body which has been composed of their metamorphosed and diversely combined or confluent brethren. So included, any such cell, or its nucleus, may commence and repeat the same processes of growth by imbibition, and of propagation by spontaneous fission, as those to which itself owed its origin; followed by metamorphoses and combinations of the cells so produced, which concur to the development of another individual; and this may be, or may not be, like that in which the secondary germ-cell was included.

In the previous Lectures we have seen that, in proportion as the subjects of anatomical investigation descend in the scale of animal life, the number of the derivative nucleated cells which retain their individuality and spermatic power is greater, and the number of those that are metamorphosed into tissues and organs less.

Cells predominate in the tissues of the vegetable kingdom, the lower members of which consist exclusively of them, and have been thence called "plantæ cellulares:" the lowest of all consist of a single cell.

We have seen that the animal kingdom starts from the same elementary beginning: a cell-wall forms the smooth elastic and contractile integument of the *Gregarina:* a fluid and granules, with a firm nucleus, containing sometimes a nucleolus—the ordinary cell-contents—are the sole representatives of organs or viscera. Yet the power of the *Gregarinæ* to live and grow independently by assimilating foreign nutriment, the vital contractility of their tegumentary tunic, their chemical composition, and their definite forms, with such well-marked specific characters, in a few instances, as the *Greg. brevirostris* and *Greg. Sieboldii* present, render their interpretation, as a low and primitive form of parasitic animal, the most accordant with actual physiological and zoological knowledge.

A large proportion of the nucleated and impregnated cells is retained unchanged in the compound

hydriform Polypes and in the parenchymatous Entozoa: a smaller proportion in the Acalephæ and cavitary Entozoa. We find derivative germ-cells and masses of nuclei like those resulting from the final subdivision of germ-cells retained unchanged at the filamentary extremities of the flabelliform uterus, and forming the ovaria of the larval *Aphides*. By the observation of this phenomenon in the newly-hatched larval *Aphis* from the ovum deposited by the oviparous species, and by reflection on the relation of the observed germ-masses to the successive spontaneous fissions of the primary impregnated germ-cell, and to the effect of such spontaneous fissions in the subdivision and diffusion of the spermatic force, I arrived, some years ago,(a) at what I felt to be a clear insight into the circumstances which rendered the successive generations from virgin Aphides possible and conceivable, and I have the greater confidence in the truth of that in sight from having found it equally explanatory of the analogous phenomena of "Lucina sine concubitu" in other animals.

It is now more than a century since Bonnet, in his "Traité d'Insectologie," 8vo., 1745, first attracted the attention of physiologists and naturalists to this mode of generation in the *Aphides* or plant-lice. And because it was the first of a large class of phenomena, till then utterly unknown and unsuspected, it was received with considerable doubt, or met by total incredulity.

The facts are briefly these:—

The impregnated ova of the Aphis are deposited, at the close of summer, in the axils of the leaves of the plant infested by the species, and the ova retaining their latent life through the winter, are hatched by the returning warmth of spring; a wingless hexapod larva is the result of the development. This larva, if circumstances, such as warmth and food, be favourable, will produce a brood, and indeed a succession of broods, of eight larvæ, like itself, without any connexion with the male. In fact, no winged males, at this season, have appeared. If the virgin progeny be also kept from any access to the male, each will again produce a brood of the same number of aphides; and carefully prosecuted experiments have shown that this procreation from a virgin mother will continue to the seventh, the ninth, or the eleventh generation before the spermatic virtue of the ancestral coitus has been exhausted.

When it is so exhausted, a greater proportion of cells in the germ-masses developed from the remnant retained by the last procreant larvæ are used up; individual growth and development proceed further than in the parent; some members of the last larval brood are metamorphosed into winged males, others into oviparous females; the ova are impregnated and oviposited, and thus provision is made for disseminating the individuals and for continuing the existence of the species over the severe famine-months of winter.

These phenomena, first observed, as I have said, by Bonnet, in the genus *Aphis*, were the first to which the thoughts of physiologists were bent to explain. But, being viewed in the light of a strange and anomalous exception, and at a period when the phenomena of embryonic development were not known, the earliest steps more especially, success could not be expected.

Reaumur eluded the difficulty of the fact which Bonnet had discovered, by affirming the Aphides to be androgynous. The vagina in the perfect oviparous females has appendages called spermatheca and colleterium; and Reaumur might have even appealed to the microscope in support of his idea, for he might have detected, by its aid, spermatozoa in the spermatheca. But this would not have proved the hermaphroditic structure; for the spermatheca receives the intromittent organ of the male, and retains the semen in store for the successive impregnation of the ova as they pass out; the ova at the same time being coated by the adhesive and protective matter of the colleterium. These appendages of the vagina are found in most oviparous insects; and the true male *Aphis* is as well known now as that of any other species of insect. Moreover, it is found, that the viviparous virgin larvæ of the *Aphides* have not got a trace of those appendages of the vagina, which Reaumur supposed to be male organs. They were not required in her mode of generation, and are not developed; the germ-cell already exists in her, with sufficient spermatic and plastic force for its development: no semen, therefore, was required to be retained, and there is no spermatheca; the embryonic development is completed *in utero*, and no secretion for the protective covering of ova was needed. The structures, therefore, which Reaumur, under a misconception of their nature, cited in order to solve the problem of the alleged virgin procreation, are present only in that perfect form of *Aphis* where no such phenomena are manifested.

Leon Dufour, whose extent of research and comparison of the generative organs of insects led him to a true appreciation of the nature and function o the appendages to the female organs of the oviparou *Aphides*, referred the phenomena of the generation of the larviparous *Aphides* to "spontaneous or equivocal generation." Now, if we consider what we actually learn from these words,—that the larvæ produced by the virgin Aphides are produced by "spontaneous" or equivocal generation,—it will seem to be little more than another mode of stating the fact. The condition or mode of the fact, the phenomena rendering it possible, are not explained by them; M. Leon Dufour, however, meant to record his belief in a hypothetical mode of generation, in which, as he expresses it, "the act of impregnation was in no degree concerned." Having detected the male Aphis, and well scrutinized the structure of its organs, having witnessed the coitus with the winged female, and carefully excluded the male in repeating the observations and experiments of Bonnet, M. Dufour satisfied himself, and affirmed, that impregnation had no share whatever in the phenomena of the development of the larval aphis in the body of another virgin larval aphis.

With regard to the hypothesis of spontaneous generation, the reasons which have led me to concur with most physiologists of the present day in rejecting it were fully given in a former Course of Lectures on the subject of Generation, nine years ago, and every exact observation and experiment subsequently recorded serve to render that hypothesis less tenable and more gratuitous.

Professor Morren, a comparatively recent and very exact observer of the anatomy and generative economy of the *Aphides*, retaining the hypothesis of spontaneous generation as it has been applied to the Entozoa, propounded, though not without reserve, a theory that the larval aphides were developed in the body of the virgin parent, like Entozoa, "by the individualisation of a previously organised tissue." Now here also is a phrase which, when the meaning of it is analysed, does little more than express the old facts in a new way. When a larval aphis is developed, a new individual exists; in other words, it has been "individualised;" and, as nothing can come out of nothing, it must have been by the individualisation of a previously existing something. The question to be solved is, what is that something, and what has happened to that something to make its individualisation under the form of a larval aphis possible and conceivable by us according to the known analogies of other embryonic developments or individualisations? That would be the explanation of which we are in quest,—an explanation going as far as that which we are able to give, for example, of the development of an ordinarily impregnated ovum; and, by the proved analogy of the essential condition of the development in the virgin aphis with that condition in the impregnated ovum, capable of having every advance of knowledge of the operation of such essential condition applied to it.

When, however, M. Morren affirms "que la génération se fait ici, comme chez quelques Entozoaires, par l'individualisation d'un tissu précédemment organisé," the objection immediately arises, that no one has ever seen a portion of mucous membrane, muscular fibre, or other organised tissue detach and transform itself into an entozoon: such a process is as gratuitously assumed, and as little in accordance with observed phenomena, as "spontaneous generation" in the abstract. In a former Course I objected, that "The fissiparous nucleated cells of the ovum, once metamorphosed into a tissue, can produce nothing higher, and nothing else save by their decay, which products are excreted; but the cells which retain their primitive state amidst the various tissues which the rest have constituted in building up the body of the new animal may, by virtue of their assimilative and fissiparous forces, lay the foundation for a new organism." I shall not, however, here pursue the argument, which is carried out in my published "Lectures on the Anatomy and Physiology of the Vertebrate animals."

The learned and ingenious authors of the deservedly popular "Introduction to Entomology" admit it to be "an incontestible fact that female Aphides have the faculty of giving birth to young ones without having had any intercourse with the other sex," and they suppose "that one conjunction of the sexes suffices for the impregnation of all the females that in a succession of generations spring from that union." They adduce, in order to show that such a supposition is not contradictory to the general course of nature in the production of animals, the case of the hive-bee, "in which a single intercourse with the male fertilizes all the eggs that are laid for the space of two years;" and the case of a common spider, showing "that the sperm preserves its vivifying powers unimpaired for a long period, indeed a longer period than is requisite for the impregnation of all the broods that a female Aphis can produce." But these instances do not touch the question how one of such a brood, insulated from all connexion, should give birth to others. Admitting that this phenomenon may depend on the inheritance of the impregnating principle transmitted from generation to generation, the problem for the natural philosopher to explain is, how this is brought about. The superaddition of the "spermatheca" to the vagina of the queen-bee, as of other oviparous insects, plainly accounts for the fact in the economy of that insect which Messrs. Kirby and Spence quote, according to the function of the part determined by the well-devised experiments of Hunter on the silk-moth. (On Bees, Philos. Trans. 1792, p. 175.) To say that one conjunction of the sexes suffices to impregnate the females of the successive generations of Aphides springing from that union, is little more than a statement of the fact; and it seems to have been so felt by the able entomologists cited, who conclude their remarks by confessing—"It is, however, one of the mysteries of the Creator that human intellect cannot fully penetrate." (a)

The completion of an embryonic or larval form by the development of an ovarian germ-cell, as in the Aphis, without the immediate reception of fresh spermatic force, has never been known to occur in any vertebrate animal.

The condition which renders this seemingly strange and mysterious generation of an embryo without precedent coitus possible, is the retention of a portion of the cells of the germ-mass unchanged. One sees such portion of the germ-mass taken into the semi-transparent body of the embryo Aphis, like the remnant of the yelk in the chick. I at first thought that it was about to be enclosed within the alimentary canal; but it is not so. As the embryo grows it assumes the position of the ovarium, and becomes connected with the filamentary extremities of the eight oviducts. Individual development is checked and arrested at the apterous larval condition. It is plain, therefore, that the essential condition of the development of another embryo in this larva is the retention of part of the progeny of the primary impregnated germ-cell.

What is really surprising in the phenomena of the Aphides is the potency of the mysterious virtue of the quintessential excretion, which sustaining so great a degree of subdivision, and of dilution with the material incorporated in the successive generation of cells, is nevertheless equal to the renewal and repetition of embryonic development through so many generations.

The generation of a larval Aphis may be repeated

(a) "Lectures on the Comparative Anatomy and Physiology of the Invertebrate Animals." 8vo. 1843. Pp. 234.

(a) Introduction to Entomology, vol. iv .p. 161.

from seven to eleven times in as many successive virgin generations, without any more accession to the primary spermatic virtue of the retained cells than in the case of the successive development of polypes in the compound zoophyte, or the successive budding of the individual leaves in the equally compound plant: one might call the generation of the virgin aphides an "internal gemmation," but this phrase would not explain the conditions essential to the process, unless we previously knew those conditions in regard to ordinary or external gemmation.

At length, however, the last apterous or larval Aphis, so developed, proceeds to be "metamorphosed," as it is termed, into a winged individual, in which only the fertilising filaments are formed, as in the case of the stamens of the plant; another larval Aphis perfects the generative organs, and developes the ovules, as in the case of the pistil. We have, in fact, at length "male and female individuals," preceded by procreative individuals of a lower or arrested grade of organisation, analogous to the gemmiparous polypes of the zoophyte and the leaves of the plant.

I have described the process for its better intelligibility in the Aphides as one of a simple succession of single individuals, but it is much more marvellous in nature. The first-formed larva of early spring procreates not one but eight larvæ like itself in successive broods, and each of these larvæ repeats the process; and it may be again repeated in the same geometrical ratio until a number which figures only can indicate and language almost fails to express, is the result. The Aphides generated from virgin-parents, by this process of internal gemmation, are as countless as the leaves of a tree, to which they are in some respects analogous.

It generally happens that the metamorphosis which I have described as occurring after the seventh or eleventh generation takes place much earlier in the case of some of the thousands of individuals so propagated: just as a leaf-bud near the root may develope a leaf-stem, a flower and seed-capsule, with much fewer antecedent generations of leaves from buds than have preceded the formation of the flower at the summit of the plant; or just as one of the lower and earlier formed digestive polypes may push out a bud to be transformed into an ovarian sac and a generative medusa. The analogy is beautifully and closely maintained throughout.

The wingless larval aphides are not very locomotive; they might have been attached to one another by continuity of integument, and each have been fixed to suck the juices from the part of the plant where it was brought forth. The stem of the rose might have been incrusted with a chain of such connected larvæ as we see the stem of a fucus incrusted with a chain of connected polypes, and only the last developed winged males and oviparous females might have been set free. The connecting medium might even have permitted a common current of nutriment contributed to by each individual to circulate through the whole compound body. But how little of anything essential to the animal would be affected by cutting through this hypothetical connecting and vascular integument and setting each individual free! If we perform this operation on the compound zoophyte, the detached polype may live and continue its gemmiparous reproduction. This is more certainly and constantly the result in detaching one of the monadiform individuals which assists in composing the seeming individual whole called "volvox globator;" and so, likewise, with the leaf-bud. And this liberation Nature has actually performed for us in the case of the Aphis, and she thereby plainly teaches us the true value or signification in morphology of the connecting links that remain to attach together the different gemmiparous individuals of the volvox, the zoophyte, and the plant.

The phenomena of parthenogenesis have not been manifested in any articulate animal of higher organisation than insects: they cease at a lower grade of the parallel series of the molluscous invertebrata. In some lepidopterous insects, which have been supposed to have the faculty of producing fertile eggs without sexual intercourse, closer observation has shown the mistake to have arisen from the unusual circumstances under which the act of impregnation takes place. This is the case with the moths of the genus *psyche*, which the German entomologists call "sac-träger" from the remarkable cases or sacs which the larvæ inhabit. The true state of the case has been explained by the observations of Von Scheven and Siebold. The females of these moths never acquire wings, but develope their ova under a grade of metamorphoses very little beyond that of the larval state.

The larvæ which become females fabricate an entirely different cocoon from that of the larvæ which become males, and the sexes of such larvæ are readily distinguishable by such cocoons. Von Scheven secluded one of these virgin female larvæ of the *Psyche vestila*, and found that she laid only barren eggs.

Certain female larvæ live quite separate from the males on special peculiar feeding-localities. When about to become pupæ, most of the cocoon-bearers leave those localities, and attach the mouth of the cocoon to branches of trees, to stones, or rocks.

Before becoming pupæ, the grub turns itself in the cocoon, and brings its head opposite the hinder or lower free opening of the cocoon.

The female pupæ manifest very little motion, but remain passive at the upper end of the sac, by which it is suspended; whilst the active male pupæ protrude their thorax from the lower opening of the cocoon shortly before emerging as the perfect moth.

The almost apodal maggot-shaped females cast their pupa-skin without quitting the cocoon; they wait, in the hinder or lower free end of the cocoon, the approach of the male, which accomplishes the act without ever seeing the female of his choice.

The male Psyche has not the penis of any remarkable length, but he is able to elongate considerably the abdomen; the skin of that part is soft and extensible; he inserts the abdomen into the hinder opening of the female cocoon, and brings the external genitals into connexion with the copulatory canal of the female. After the coitus, the female, which has no ovipositor, pushes herself back again into the cast pupa-skin, and there oviposits. Also, if such a female, awaiting the male, be disturbed at the closed end of the cocoon, she returns and betakes herself wholly within her old shed pupa-skin. In the allied genus *Talæporia*, the larviform females emerge from the hinder aperture of their short cocoon, and creep, by means of their well developed legs, to the under side of the cocoon; the generative act being performed in open day. These females have a long ovipositor, and by means of it they fill their old pupa-skin with the impregnated ova. The procreant female of *Psyche* is maggot-shaped, has no fully-developed legs, no articulate antennæ, nor distinct eyes; neither has she a trace of an ovipositor; the last abdominal segment consists only of a short fleshy cylinder, on which a short oviduct opens. The colleterium is a double pyriform glandular sac, with a short common duct. A spermatheca communicates, by a short convoluted duct, with the common vagina, which has two lateral fleshy folds, and is connected with a round bursa copulatrix, with thin and delicate walls.

Such accessories to the flabelliform ovaria and short oviducts of the *Psyche* are of themselves sufficient to show that her ova are destined to be impregnated. The idea that the females of this genus of moth were parthenogenetic would, however, naturally arise from observation of insulated facts in the singular series of her generative processes. Our science ever presents a picture of truth evolving itself by slow degrees from the misapprehensions of observers. An entomologist collecting the female Psyche in her unusually early arrested stage of metamorphoses, and without cognizance of the singular mode of her impregnation, would at first conclude, from the analogy of other moths, that she was a virgin pupa; and, keeping her carefully insulated, would be astounded by her abundant production of fertile ova. Or, if ignorant of the peculiar place of her natural oviposition he might well mistake the shed pupa-case, filled with fertile eggs, for an actual pupa in which such eggs had been developed.

There are many striking and beautiful manifestations of instinctive prescience in the modes of oviposition, and in the location and attachment of the ova. Observe the actions of the common white butterfly. Its food is the nectar of flowers; but, after impregnation, she flits about with a purpose quite distinct from anything connected with the act of supplying herself with food; but, if the plant suitable for the food of the larvæ to be developed from her eggs happen to be within the range of her flight, it will soon be seen what her object is. The larvæ of most *Lepidoptera* infest, and can only be nourished properly by, the leaves of particular plants: thus, the mulberry is suitable to the silk-worm, and the cabbage to the *Pieris brassicæ;* when that commonest of our butterflies has found the cabbage, she has attained the end of her quest, and proceeds to the work of oviposition. But a more striking illustration is found in the ichneumon-fly, which is remarkable for the great length of the anal appendages. Her food, also, is nectar; but her chief occupation in crossing over the leaves of trees and plants, after being impregnated, is to discover the larvæ that may be lurking in the bend of the folded leaf, preparatory to its change into the pupa-state. The ichneumon, by means of her peculiarly long, sharp, and slender ovipositor, pierces the skin of the larva, and, in spite of their writhing, and the ejection of an acrid fluid, she succeeds in perforating that skin, and, then, by divaricating two parts of the sheath of the ovipositor, makes a little canal by which the ova are transmitted and lodged under the skin; she then flies off to seek another. Sometimes the female ichneumon, when she has found a larva, seems to take no notice of it; and, in that case, it has been found that another ichneumon has previously oviposited there, and, by some peculiar sense, she ascertains that there is no room for more ova, or not food enough for such when hatched. After the ichneumon has deposited the ova, she plasters over the wound with the colleterial secretion. In the insects of the genus *Cynips*, which are nearly allied to the ichneumons, the female has an ovipositor very similarly modified; its place for oviposition is the leaf of the willow; and the ova excite an action in the cellular tissue of the leaf, which results in the formation of a warm and nutritious bed for the larvæ. The products called "nut-galls" result from a similar procedure of the *Cynips Querci*. In an insect allied to *Aphis*, the *Chermes*, or *Psylla abietis*, the last act of the oviparous female, at the close of summer, is, to deposit her ova in the rudimentary leaves of the fir-tree, when these leaves, instead of growing to the length of the others, become thickened, and are converted, by the irritation of the ova of the Chermes, into a series of cells of a compact structure. In this specimen (showing No. 2972) a section has been removed, showing the cavities containing the larvæ. Here (showing No. 2975) is a specimen of the article in the old *Materia Medica*, called "Bedeguar." It is a twig of the common wild rose, from the end of which a tuft of mossy fibres has shot out, in consequence of the irritation induced by the presence of the ova and larvæ of the *Cynips Rosæ*. Hunter has made a section of this monstrous growth, exposing several of the nidamental cavities and their small white larvæ.

In the gad-fly (*Æstus bovis*) the ovipositor is like a telescope, terminated by boring instruments; by means of these the integument of the ox is perforated, and the egg is then deposited underneath the skin; a peculiar kind of inflammation is set up, followed by hypertrophy and condensation of the cellular tissue, and in the nidus thus produced the larvæ are developed. In the Bott-æstrus (*Gasterophilus equi*) the ova are destined to be incubated in the alimentary canal of the horse; and one might wonder how their passage could be insured into such a locality. The instinct of the female impels her to attach the ova to the hair of those parts of the body which is most readily reached by the horse's tongue; the irritation of the attached ova excites the action, and so they are licked off and swallowed. Many insects deposit their eggs in the earth, and the females of such are provided with instruments for digging. (A preparation of a locust was exhibited, showing the peculiarly modified shape of the ovipositor.) It consists of two elongated valves; these, in close juxta-position, are thrust into the earth, like the gardener's dibble; the valves are then separated by muscles, and the

eggs are protruded along the outer space and deposited like a seed in the ground. The analogous part in the bee is that which forms the sting, which, as the defensive instrument of the nursing female, has a certain relation to the well-being of the young. Many insects not only provide the germ with the nutritive vitelline mass, or the material for the first development of the embryo, (if, indeed, the parent can be said to be concerned in that supply which is the result rather of a series of spontaneous fissions with an inherent power of assimilation of the primitive germ-cell itself,) but, in some cases, the parent having selected a fit place for the deposition of her precious burthen, continues the maternal office by placing near the ovum the kind of food which the larva will necessarily require in order to complete its growth.

Some insects, as bees and ants, feed the larva; supply them with the required food from time to time, as nurses satisfy the cravings of a child; but these cares rarely devolve upon the mother in the insect class: they are performed by a distinct race of individuals, of the feminine sex, but incapable themselves of exercising the procreative faculty.

The forms of the eggs of insects are very variable; often beautiful and regular, like the seeds of plants; sometimes very singular; always perfectly adapted to the required conditions for the development of the future insect. The eggs are cylindrical in *Bombyx everia;* conical, with tuberculate ribs, in *Pontia napi;* hemispherical in *Bombyx dumeti;* lenticular in *Noctua psi;* cup-shaped in *Orgyia antiqua;* flask-shaped in *Culex pipiens;* petiolate in *Hemerobius perla;* provided with diverging processes like ears in *Scatophaga putris,* to prevent their sinking too deep in the soft dung; provided with a special adaptation for floating in some aquatic insects; with numerous other modifications.

When impregnation has taken place, the germ-yelk becomes condensed, as in the Ascaris, receding a little from the vitelline membrane at its poles. The usual processes of subdivision take place, but in so much greater a degree at the peripheral layer that the subdivided vitelline mass becomes invested by a stratum of minute and nucleated cells. Kolliker, who has observed these early stages of insect development in the *Chironomus tricinctus* Schrank, gives the following account of the process. The primordial cells, at first round, and provided with one nucleolus, become afterwards elliptical, and generally two nucleoli can be discerned in them; afterwards two cells exist, of smaller size than the parent cell. He concludes, that this fissiparous generation of cells, which accords with that observed by Siebold and Bagge in the Ascaris, is the general mode of their multiplication:—"Hæc omnia, etsi nunquam cellulas in aliis inclusas offendi, ne ad sententiam adducunt, posteriores a prioribus gigni, ita semper binæ in unaque cellula matre oriantur." (a)

The vitelline mass becomes elongated and vermiform, and, by further subdivision and coalescence of the peripheric stratum of the derivative germ-cells ("cambium" of Herold), a small transparent integument is formed, like that in the Entozoon, first along the ventral aspect, then ascending up the sides to the dorsal aspect, which is likewise closed in by the reciprocally approximating folds which cover first the cephalic and then the caudal segments. The portion of the germ-mass remains long unchanged in the anal segment of the larva of the bee. No part of the yolk can be properly said to enter or be taken into the body of an insect. It never was out of the body: it is a "germ-yolk;" and forms the basis of the future body: there is no appended or superadded vitellus, as in the shark or bird. The division of the integument into the thirteen segments commences at the ventral aspect, which is convex, the vermiform body of the embryo being, at first, bent upon the back.

In the capitate larvæ the entozoal type is quickly left by the cervical constriction, and the development of a distinct head, which commences by the formation of the part afterwards retained as the labrum. The mandibulæ and antennæ next appear behind the labrum as convex lobes; and the part of the head in the lower interspace of the mandibles forms the labium. The maxillæ next bud forth between the labium and the mandibles, and the median fissure, surrounded by the rudimental trophi, sinks deeper into the substance of the head, and, meeting a slender anterior production of the internal vitelline sac or cavity, establishes the mouth and œsophagus. Whilst these stages are in progress, the peripheral series of included vitelline cells have undergone a series of spontaneous fissions; whereby the remaining mass becomes included within a second stratum or cambium, which, by coalescence and further metamorphoses of the cells, is transformed into the tunics of the alimentary canal, the interspace between which and the outer integument forms the abdominal cavity. A certain proportion of the vitellus, not included in the ellipsoid alimentary canal, has undergone transformations, by which the foundations of the muscular system, the ventral nervous chord, and the dorsal vessel, are laid. An attenuated posterior prolongation of the ellipsoid vitelline or alimentary sac forms the rectum, and opens upon the thirteenth segment, while it is bent upon the dorsal aspect.

In such a condition, but without the cephalic and trophal development, the entoziform of the flesh-fly is born or excluded from the parent: in a similar condition the larva of the bee and of the parasitic Hymenoptera quits the vermiform ovum, but without the external communication with the digestive or vitelline sac having been established at the posterior extremity.

In some Coleoptera development proceeds to the formation of the appendages of the head, as above described, and a capitate but apodal larva is excluded, as in the nut-weevil.

In the other Coleoptera, as the *Donaciæ* (a), the ventral arcs of the second, third, and fourth segments, send out bulbous rudiments of the thoracic legs, before the tergal or notal elements of the segments are completed; the abdomen is closed above, whilst the development of the extremities has proceeded to the formation of obscure joints and terminal hooks. The rudimental palpi begin to bud from the maxillæ and labium; the mandibles acquire their hard terminal hooks, and closely resemble the thoracic feet. In this state the larva is excluded.

At an earlier period the simple bulbous antennæ, mandibles, and maxillæ, indicate three cephalic segments, equal in size and distinctness to those of the thorax. The labrum and labium might perhaps be regarded as indicative of two other abortive segments; but with this concession not more than five cephalic segments can be defined by observation of the early development of the insect. The biliary and other tubular glands result from juxtaposition in a linear series of derivative nucleated germ-cells, which coalesce by liquefaction of the parts of the cell-wall in contact with each other, the nuclei remaining longer and indicating the primitive separation of the cells. The ovarian tubes have appeared to me, in the larva of the silkworm, to retain the primitive series of nuclei of the germ-cells at their capillary beginnings; whilst coalescence of the germ-cells themselves, has taken place to form the lower part of the tube: such persistent, primitive, nuclei, or granules, seem to form the basis for the formation of the subsequent ova.

(a) Observationes de prima Insectorum Genesi 4to. Turici. 1842.

London: Printed by William Tyler, Bolt-court.

No time has been lost by the friends and admirers of the late Sir RICHARD OWEN in taking steps to secure the proper commemoration of his eminent services to science. The meeting over which the Prince of WALES presided in the Rooms of the Royal Society on Saturday adopted a resolution, proposed by the Duke of TECK, to the effect that the Memorial should consist primarily of a marble statue to be placed in the hall of the Natural History Museum. That suggestion will assuredly meet with the cordial approbation of every member of the public who is acquainted with the story of the foundation of the Natural History Museum and with the persistent part which OWEN played throughout so many years in endeavouring to obtain from Government the necessary grants for the erection and organisation of that institution. One might, indeed, say that, in the light of that story, OWEN needs no statue there. "Si monumentum quæris circumspice." Nevertheless, since the memory of mankind is short, it is well that the future generations of Englishmen who visit that admirable collection should be reminded of the indefatigable labourer in the field of science who won it for them in the teeth of the most pronounced and prolonged opposition. In the sketch which he gave the meeting of the circumstances which attended the foundation of the Museum, and of the difficulties which OWEN had to meet and overcome, the Prince of WALES, by implication, directed the attention of those present to the suitability of choosing the noble institution at South Kensington as the site for any Memorial which they might desire to raise to its founder. The PRINCE has, moreover, consented to act as Chairman of the strong Executive Committee formed to carry out the proposal of the meeting. We may, therefore, look forward to the execution of a work by a British sculptor which shall be worthy alike of the intellectual greatness of the model and of his personal appearance in life—an appearance strikingly suggestive of his philosophic temperament. OWEN'S association with the Natural History collection which is now in South Kensington began when it was housed, or, perhaps, we should say warehoused, in the British Museum. The defective condition of the home of these valuable specimens was no fault of the Trustees. The collection was much too big for the space at their disposal, and no doubt they did their best in the attempt to pour a quart of liquor into a pint pot. That state of t ings would have continued to go on from bad to worse had it not been for the appointment of RICHARD OWEN as Superintendent of the Department in 1855. If, as has been said, the place was created for him, its creation constitutes the most enlightened and benevolent piece of jobbery on record, for OWEN was just the one man who could remove the mountain of official opposition and obstruction and get his beloved collection removed to better quarters. It took him seventeen years' steady hammering away with voice and pen, and every influence he could contrive to exert, to obtain his heart's desire. The Commons rejected the Museum Bill in 1862, but ten years later the erection of the South Kensington buildings was sanctioned, and on Easter Monday, 1881, the new Museum was opened. It was not until two years after that, when the work of arranging the collection in its new home had been accomplished, or nearly, that the aged Professor retired from his post, but his indefatigable love of work followed him into his retirement, and it is only some four years since he ceased to contribute papers to the Royal Society. Now that he is dead, it is well to know that his effigy will stand in the place where his thoughts were particularly centred, and will adorn the Museum which owes its existence to his unwearied advocacy.

If any thing wrong let us know

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ORIGINAL ARTICLES.

I.—Sir Richard Owen, K.C.B., M.D., D.C.L., LL.D., F.R.S., F.L.S., F.G.S., V.P.Z.S., Pres. Pal. Soc., Assoc. Inst. France.

(With a Portrait.)

In recording the regret which the world of science feels at the loss of Sir Richard Owen, we seem to stand in a more intimate and personal relation to him than many others, from the fact, that he was not only one of the early and frequent contributors to the Geological Magazine, but also was the official colleague of the writer during a quarter of a century.

Born at Lancaster on the 20th July, 1804, Owen was destined for the Medical profession, and passed from school to college in Edinburgh, where he matriculated in 1824, passing his medical examinations and becoming a member of the Royal College of Surgeons in 1827.

About this time, his love of science was stimulated by a short residence in Paris, during which he attended the lectures of the illustrious Cuvier, then at the zenith of his greatness. After a brief period of private practice, he gladly accepted the position of Assistant-Curator of the Hunterian Collections in the College of Surgeons, conferred upon him on the recommendation of the celebrated Dr. Abernethy. Here he revelled in the examination of the uncatalogued preparations of Dr. John Hunter, the most distinguished surgeon of the last century.[1] He undertook the preparation of a series of Descriptive and Illustrated Catalogues of the specimens of Physiology and Comparative Anatomy; and later on, those of Natural History, Osteology, and Fossil Organic Remains preserved in the College Museum (1833–40). In 1834 Owen was elected to the Chair of Comparative Anatomy in St. Bartholomew's, carrying the title of "Professor;" and in 1835 married the daughter of Mr. William Clift, Curator of the Hunterian Museum, his old chief officer. In the following year he gained the fellowship of the Royal Society and the post of Hunterian Professor in the Royal College of Surgeons, which he held until his appointment to be Superintendent of the Departments of Natural History in the British Museum in 1856.

Whilst engaged upon the large series of Catalogues for the College of Surgeons' Museum, Owen obtained permission to dissect such

[1] In this task he was assisted by his life-long friend Mr. (now Sir James) Paget.

animals as the Zoological Society's menagerie could from time to time supply, and this enabled him to contribute a long succession of most valuable papers to the Proceedings of the Society's Journal and elsewhere.

Valuable as are these memoirs, we naturally turn to Owen's palæontological labours as affording the matter of greatest interest to geologists.

Most interesting of these is his Monograph on the Fossil Mammals of the Mesozoic Formations (1871), which, although late in date, embodies much of his earlier work, and contains thirty species from British localities, such as Frome, Stonesfield, and Purbeck. This, together with his memoirs on the Red Crag Cetacea (1869); the Reptilia of the London Clay (1848–56, and 1880); of the Cretaceous Formations (1851–64); of the Wealden and Purbeck (1871–79); of the Kimmeridge Clay (1859–69); of the Mesozoic Formations (1873–77); forming a large series of Monographs, have all appeared in the annual volumes of the Palæontographical Society, embracing descriptions of 139 species of reptilia and nine species of cetacea.

Of his contributions to scientific societies it would be quite beyond the scope of this brief notice to give a detailed account.[1] His Memoir on the Pearly Nautilus appeared as early as 1832; his paper on a Belemnite from the Oxford Clay in 1844; his "History of British Fossil Mammals and Birds," in 1846; his "History of British Fossil Reptiles," 1849–51; his Palæontology in 1860, and 2nd Edition (1861). Among his Memoirs on foreign fossils may be mentioned that on the gigantic extinct sloth *Mylodon* (1842); on the *Megatherium* (in 1860); his series of Memoirs on the "extinct Marsupialia of Australia;"[2] the "extinct Birds of New Zealand;"[3] his memoirs on the *Archæopteryx*,[4] and the Dodo,[5] and on the fossil reptilia of South Africa,[6] are the most important. Of the twenty papers in this MAGAZINE the first appeared in 1865, and the last in 1883; the series form good examples of his short papers on palæontological subjects; and nearly every one is the description of some good fossil which had been brought to his notice.

In 1856, the question of the severance of the Natural History Departments of the British Museum was before Parliament, and after a prolonged discussion, Mr. Panizzi (aided, no doubt, by Lord Palmerston) held his position of Principal Librarian and *chief Executive Officer* of the British Museum, and Professor Owen was appointed Superintendent of the Natural History Departments, but without a separate administration. This enabled him to escape from all official routine, save one annual report, and signing the Keepers' monthly reports, and with now and then a special word of recommendation. He also gave a course of 12 lectures annually in the Lecture-Theatre of the Jermyn Street Museum; but only for a few

[1] The Royal Society's Catalogue of Scientific papers puts the number at 360; which does not include his works published separately.
[2] Phil. Trans. Royal Soc.
[3] Trans. Zool. Soc. London.
[4] *Ibid.*
[5] *Ibid.*
[6] Published by the Trustees of the British Museum.

years. This will explain why at this period of Owen's career, from 1856 to 1880, he was so prolific in papers and memoirs.

The event of the Great Exhibition brought Owen (as the President of one of the Juries) under the notice of the Prince Consort, and he speedily became a recognised favourite with the Queen, and was frequently requested to deliver lectures on Natural History before Her Majesty and the Royal family. By the Queen's favour he received a residence, Sheen Lodge, Richmond Park, and a Civil List pension, both of which he enjoyed until the time of his death. He was President of the British Association at Leeds, in 1858; and was succeeded by the Prince Consort at Aberdeen, in 1859.

Although (away from Monte Carlo) every one is too well-educated to believe in "being born under a lucky star," nevertheless, we may safely affirm that Owen was born at a most fortunate time, and in a century marked by the greatest progress in science, commerce, and literature that the world has ever known.

Owen lived on into the new era of steam-locomotion, of telegraphs, of cheap printing, of good illustrations, of higher education; indeed, it is not too much to assert, that Owen like his contemporaries, Herschell, Faraday, Lyell, and Darwin (together with many others), helped to bring on this great advance in civilization.

But for the vast amount of solid anatomical and palæontological work which Owen had accomplished, much of Lyell's work could not have been effected, and the theory of Natural Selection and the Origin of Species could not have appeared so soon. Indeed, when in the end of 1859, Darwin's first edition of the "Origin of Species" appeared, Owen claimed to have enunciated similar views *long before.* Nevertheless, when Darwin begged to be permitted to quote Owen as a supporter of his views, or as favourable to them, he declined to accept them, and classed them as a new phase of Lamarckianism which we should most of us live to see die a natural death. This was not generous, and contrasts strongly with Lyell, who having held to the old uniformitarian views for many years, and to the fixity of species, abandoned his old views, and accepted the new doctrines with an open mind.

The real secret, perhaps, lay in some anxiety felt by Owen lest he should lose popularity and give offence to the higher clergy, and to my lords, and (as the Catechism expresses it) "to those who are put in authority over us!"

The success that attended him in his long life resulted from a combination of circumstances. Everyone will readily admit the fact of Professor Owen's extraordinary genius, his sagacity in interpretation, and his remarkable ability as a lecturer; but behind these he owed very much to his indomitable energy and power of sustained work; to his marvellous flow of language, to his vigorous bodily health, and, in controversy, not a little to his cleverness both in defence and attack. His courteous manners, when dealing with the general public, were proverbial, and also the marked attention which he paid to the rank of the individual.

He was fortunate in belonging so early in the century to the medical profession, then standing almost alone as a body of most intelligent and able men of science (for the eminent chemists and engineers have arisen since). They could not spare time to criticize Owen's work, but they were as a body most generous and appreciative, and but few ever opposed him. He was happy in being appointed to the charge of the Hunterian Collections, for so many years kept back from publication by Sir Everard Home, who had promised to edit the Hunterian MSS. also, but failed to do so. Add to this his special opportunities and facilities for comparative anatomical studies, afforded by the Zoological Society; but most of all, to his choice of palæontology, then a virgin field of research, over which he was free to travel far and wide, and to reap for years golden harvests almost unchallenged by other workers. So unused was he to rivalry in his special lines of research that when younger men, like Falconer, Busk, G. R. Waterhouse, Huxley, and others, took the field, he became most keen to watch the "quarry," and when espied, even from afar, Owen eagle-like, would pounce upon and carry off the coveted spoil; indeed his whole nature seemed transformed in the presence of a new and undescribed fossil, so eager was he to take the field and describe it, or (as frequently happened) if the new discovery arrived at an unpropitious moment, he was equally eager to conceal his treasure from the curious and inquiring eyes of youthful aspirants.

It is pleasant to turn from the small struggles and weaknesses, which great men are apt, like lesser ones, to betray, and remember the solid advantages which Owen gained for us by long years of continuous and earnest work; even his very love of high and exalted personages has resulted in solid gain to science in the acquisition for the nation, through his persistent advocacy for twenty years, of the magnificent building in Cromwell Road, in which are now preserved the entire series of Natural History Collections, formerly overcrowded and inadequately housed in the old Museum Buildings in Great Russell Street.

This notice would be still further incomplete were we to omit to remember the fact that Owen was able to shake off his scientific aspect and become, at Sheen Lodge, the amiable host and the accomplished guide to the beauties of his own wilderness garden at the back of Sheen Lodge, or to the wider and more extensive charms of Richmond Park. As a raconteur Professor Owen was inimitable. He had delightful stories to tell of Thackeray, of the Emperor of Brazil (who came out from London to visit him at 7 o'clock in the morning), of the gracious visits paid him by the Royal family; of his winters spent in Egypt; one winter in the company of H. and H.R.H. the Prince and Princess of Wales. He would tell of his visit to Italy to attend the Scientific Congress at Bologna, his trip to Vesuvius, and his visit to H.M. Bomba, king of Naples (now happily dethroned and gone): or of his visit to the Vicomte de Lastic, to secure for the Museum the grand

collection of weapons, and human and animal remains from the cavern of Bruniquel in the Valley of the Aveyron.[1]

He loved to recall the series of Lectures given before the Queen in the "White Drawing Room" at Windsor, when he astonished the Venerable Dean of Windsor with the information that "tadpoles" turned into toads and frogs.

There too were pleasant meetings (not for the promotion of science but of harmony), both at Lincoln's Inn Fields, and at Sheen Lodge, and also at the houses of Dr. Farre, and Sir James Paget, when quartette parties met to discuss sweet music; when Owen and Waterhouse played on the violoncello and the violin, Mrs. Waterhouse and her daughter on the piano, whilst Paget, Farre, and others joined in. Alas! they are nearly all gone over to the great majority: into the land of the great departed, into the silent land—yet not silent are the memories of their survivors who can recall some of those pleasant meetings long ago.

Upon his retirement from office H.M. the Queen graciously conferred upon him the title of Sir Richard Owen, K.C.B., but in our memories he will still remain "Professor Owen."

With gradual decrease of his bodily powers, he passed away on the 18th Dec., 1892.

We stood by Sir Richard Owen's grave on December 22nd, in the quiet churchyard of the little village of Ham, where he was laid to rest, by his own desire, beside his loving and faithful wife.

To-day (January 21st) has witnessed one of the most representative gatherings of men of science at the Royal Society which has been seen for years. H.R.H. the Prince of Wales occupied the chair, supported by H.S.H. the Duke of Teck, Lord Kelvin, and Lord Playfair; Sir James Paget; Sir A. Clark; Sir Frederick Leighton; Prof. Huxley; Sir A. Geikie; Sir John Evans; Prof. Stewart; Sir William Flower, Mr. W. Percy Sladen, Dr. Günther, Mr. Carruthers, Mr. Fletcher, Prof. F. J. Bell, Mr. E. A. Bond, Mr. Thompson, Sir H. Acland, Prof. Michael Foster, Dr. P. L. Sclater, Mr. T. Bryant, Sir George Stokes, Sir Frederick Abel, Prof. T. R. Jones, and more than 200 others were present, to consider the desirability of commemorating, by some suitable memorial, the eminent services of Sir Richard Owen in the advancement of our knowledge of the sciences of Anatomy, Zoology, and Palæontology. The first proposition, that there be a memorial, was moved by Lord Kelvin, Pres.R.S., and seconded by the Rt. Hon. T. H. Huxley, F.R.S. The second, that the memorial be in the form of a marble statue, to be offered to the Trustees, to be placed in the Natural History Museum, which Owen did so much to establish, was moved by H.S.H. the Duke of Teck and seconded by Sir William Flower. Mr. P. Lutley Sclater moved that a Catalogue of Owen's works be also prepared and printed and given to each subscriber. Sir James Paget nominated the committee, and Mr. Bryant, President of the Royal College of Surgeons, seconded the motion. Sir Andrew Clark, President of the Royal College of Physicians, nominated the Executive

[1] For which see the Phil. Trans. Roy. Soc. for June, 1864, and Abstract, Geol. Mag., 1864, pp. 137–138.

Committee, and Sir John Evans, seconded the motion. Lord Playfair also spoke. Sir Henry Acland moved a vote of thanks to H.R.H. the Prince of Wales for graciously taking the chair and consenting to preside over the Executive Committee. Prof. Michael Foster seconded the the motion.

The speeches were all kindly, generous, and eulogistic, and admirably delivered. The Prince spoke in the kindest manner of Sir Richard Owen as a personal and valued friend. The subscription list is already making excellent progress, and everything promises success to the Owen Memorial. Sir James Paget is Chairman, Sir William Flower, Treasurer, and Mr. W. Percy Sladen Secretary.

The following are the titles of Professor Owen's contributions to the Geological Magazine, 1865–1886:

Descriptions of some remains of an Air-breathing Vertebrate (*Anthrakerpeton crassosteum*, Owen) from the Coal-shale of Glamorganshire. (Geol. Mag. 1865, Vol. II. pp. 6–8, Plates I. and II.)

Descriptions of portions of Jaws of a large extinct Fish (*Stereodus Melitensis*, Ow.), probably a 'Cycloid,' with 'Sauroid Dentition,' from the 'Middle Beds of the Maltese Miocene.' (*Ibid.* 1865, Vol. II. pp. 145–147.)

On a New Genus (*Miolophus*) a Mammal from the London Clay. (*Ibid.* 1865, Vol. II. pp. 339–341, Plate X.)

Review of P. J. Van Beneden's "Recherches sur les Squalodons," (*Ibid.* 1865, Vol. II. pp. 405–411.)

On *Macrauchenia Patachonica*. (*Ibid.* 1865, Vol. II. pp. 520–523.)

On a Genus and Species of Sauroid Fish (*Thlattodus suchoïdes*, Ow.) from the Kimmeridge Clay of Norfolk. (*Ibid.* 1866, Vol. III. pp. 55–57, Plate III.)

On a Genus and Species of Sauroid Fish (*Ditaxiodus impar*, Ow.) from the Kimmeridge Clay of Culham, Oxfordshire. (*Ibid.* 1866, Vol. III. pp. 107–109, Plates IV. and V.)

Description of part of the Lower Jaw and Teeth of a small Oolitic Mammal (*Stylodon pusillus*, Ow.). (*Ibid.* 1866, Vol. III. pp. 199–201, Plate X.)

On the Mandible and Mandibular Teeth of Cochliodonts. (*Ibid.* 1867, Vol. IV. pp. 59–63, Pls. III. and IV.)

Letter from Professor Owen. (*Ibid.* 1867, Vol. IV. pp. 424–425.)

On the Distinction between *Castor* and *Trogontherium*. (*Ibid.* 1869, Vol. VI. pp. 49–56, Pl. III.)

Description of a Great Part of a Jaw with the Teeth of *Stophodus medius*, Ow., from the Oolite of Caen in Normandy. (*Ib.* 1869, Vol. VI. pp. 193–196, Pl. VII.)

Supplementary Note to the above. (*Ibid.* pp. 235–236.)

Note on the occurrence of Remains of the Elk (*Alces palmatus*) in British Post-Tertiary Deposits. (*Ibid.* 1869, Vol. VI. p. 389.)

Notes on two Ichthyodorulites hitherto undescribed. (*Ibid.* 1869, Vol. VI. pp. 481–483.)

Notice of some Saurian Fossils discovered by J. H. C. Hood, Esq., at Waipara, Middle Island, New Zealand. (*Ibid.* 1870, Vol. VII. pp. 49–53, Pl. III.)

Letter from Prof. Owen. (*Ibid.* 1873, Vol. X. p. 478.)

On an Outline of the Skull, Basal View, of *Thylacoleo*. (*Ibid.* 1883, Vol. X. p. 289, Pl. VII.)

Letter from Prof. Owen. (*Ibid.* 1884, Vol. XXI. p. 286.)

Letter from Prof. Owen. (*Ibid.* 1886, Vol. XXIII. p. 140). H.W.

II.—On a New Palæoniscid Fish, *Myriolepis Hibernicus*, sp. nov. from the Coal-measures, Co. Kilkenny, Ireland.

(PLATE III.)

By R. H. Traquair, M.D., F.R.S., F.G.S.

Of the fossil fish now described I know only two specimens, of which one is in the Manchester Museum, Owen's College, the other in the Museum of Practical Geology, Jermyn Street, London.

PROFESSOR SIR RICHARD OWEN, K.C.B., M.D., D.C.L., LL.D., F.R.S., F.L.S., F.G.S., V.P.Z.S., Pres. Pal. Soc., Assoc. Inst. France.

By Dr. H. WOODWARD, F.R.S., F.G.S.,
British Museum, London.

There has lately passed away in the quiet retirement of Sheen Lodge, Richmond Park, in his 89th year, the greatest comparative anatomist of this country, a giant among men of science, and the only man who could claim to have carried on, since the death of the illustrious Cuvier in 1832, those researches in extinct forms of animal life which Cuvier had so ably initiated in Paris in the earlier years of this century.

Richard Owen was born at Lancaster on the 20th July, 1804, just four years after Cuvier had been made Professor of Natural Philosophy in the College de France in Paris. After leaving school, Owen was sent to Edinburgh University, where he matriculated in 1824, and having duly passed his medical examinations, he came to London and was admitted a member of the Royal College of Surgeons in 1826. He acted as dissector at St. Bartholomew's Hospital, where his skill attracted the attention of the famous Dr. Abernethy, and led to his engagement as Assistant-Curator to Mr. William Clift, at the Royal College of Surgeons, whose daughter he subsequently married, and to whose appointment as Conservator of the Hunterian Collections Owen succeeded at a later date.

Profiting by the opportunity to spend some time in Paris, he attended Baron Cuvier's lectures, which so fired his love of science that he speedily abandoned practise as a medical man, and turned all his attention to a scientific career. In addition to the work on the Hunterian Collections at the College, Owen acted as honorary prosector to the Zoological Society and his memoir on the *Apteryx*; the great Ant-eater; on the Indian Rhinoceros; the Orang-utan; on the anatomy of the Cheetah; the Kinkajou; the Warthog; the Dugong; the Armadillo; the Tapir; the Hyrax; the Seal; the Beaver; the Walrus; the tree-Kangaroo; and many others, are the results to science of this period of his life. In 1834 Owen was appointed to the chair of Comparative Anatomy at St. Bartholomew's, and became "Professor." In 1835 he was elected Hunterian Professor and conservator of the Museum of the Royal College of Surgeons, and in 1836 he was elected a Fellow of the Royal Society.

Notwithstanding the arduous nature of his official work at this time, Prof. Owen managed to produce that very remarkable series of "Descriptive and Illustrated Catalogues of the Specimens of Physiology and Comparative Anatomy," of "Natural History," of "Osteology," and of "Fossil Organic Remains," preserved in the Museum of the Royal College of Surgeons (1833-40; 4to.) his "Odontography," (2 vols., 4to, 1840-45); besides a large series of separate memoirs, amongst them his contributions to "Todd's Cyclopædia of Anatomy and Physiology" (1836), see Article "Cephalopoda," &c., &c.

The great passion of Prof. Owen's life was the comparative study of recent and extinct forms of life. This led to the remarkable announcement, made in 1839, that struthious birds, as large as the ostrich, would be found in New Zealand. At that time Owen had only seen a small fragment of the shaft of a femur of a bird, but he recognised it as such, and although the greatest doubt was felt by others, his forecast proved to be true, and soon after Dr. Mantell's son sent over quite a large number of bones of the "Moa" or *Dinornis*, which furnished materials for more than twenty species and for the genera *Aptornis*, *Notornis*, *Cnemiornis*, &c., besides. These appeared from time to time in the Transactions of the Zoological Society of London, and with his memoir on the Dodo, &c., have since been published as a distinct work. His memoirs on the extinct Marsupials of Australia, and the fossil Mammals of England, the former contributed to the Royal Society, and the latter to the Palæontographical Society, were afterwards issued as two volumes, 4to. His British fossil Repitilia in the Palæontographical volumes extend from 1848 to 1877, and embrace descriptions of 139 species.

The fossil Reptilia of South Africa form a volume of the British Museum Catalogues (4to, 1876), whilst his Memoir on the extinct Sloth (*Mylodon*), 1842, and on the *Megatherium* (1860), &c., extend Owen's researches to South America also.

But whilst engaged with the Vertebrata, Owen had also a keen interest for the Invertebrate classes of animals; one of his earliest Memoirs being that on the anatomy of the animal of the Pearly Nautilus, which appeared in 1832, and is certainly amongst the most valuable and exhaustive of Owen's Monographs.

For this, and for his description of "Certain Belemnites preserved with a great portion of their soft parts in the Oxford clay at Christian-Malford, Wilts" (Phil. Trans., 1844), he received the award of a Royal Medal in 1846, from the Council of the Royal Society.

In the Catalogue of the Fossil Invertebrata in the Museum of the College of Surgeons, Owen has also described upwards of 350 specimens of Ammonites collected by John Hunter in the last century.

In 1844, Prof. Owen communicated to the British Association two papers by Madame Jeannette Power, detailing further experiments and observations made by her on the living *Argonauta argo*, prefaced by the remarks on the relation of the animal to its shell. He has also described *Rossia*, a sub-genus of *Sepiola*.

In 1848, Prof. Owen examined and dissected a portion of *Spirula reticulata* and a unique but imperfect specimen of *Spirula peronii*, and, in 1878, he again examined and described the specimen from the Cumming Collection, which was in a more perfect state of preservation than those brought home by H.M.S. "Samarang."

Owen still adhered, in this memoir on *Spirula*, to his earlier-expressed views of the hydrostatic nature of the camerated cephalopod-shell, and that the siphuncle was related with the maintenance of the *vitality* of the shell.*

*The contrary views expressed by Dr. H. Woodward, F.R.S., were originally communicated to the British Association (1870), and afterwards published in the "Popular Science Review," vol. xi., No. xliii., pp. 113-120 (1872).

The establishment by Owen of the two great divisions of the class cephalopoda, the *Tetrabranchiata*, and the *Dibranchiata*, the former embracing the Nautili, the Ammonites, and the Orthocerata; and the latter the Squids, Cuttles, Calamaries, Belemnites, Spirula, and Argonauts, has been maintained to the present day, and shows how keen was Owen's insight in fixing on the vital characters of any group. Prof. Owen's researches on the Brachiopoda were almost equally important with those on the Cephalopoda, and many of the orders which he founded have been widely accepted by other workers.

Prof. Owen described the anatomy of the "club-shell" (*Clavagella*), and showed that the great development of its mantle was an instrument capable of aiding the mollusc in the work of burrowing.

In 1837, he examined the structure of the shell of the "*Water-Spondylus*," and pointed out that the rudely and irregularly-camerated structure of its shell offered, in its mode of growth, an analogy with the chambered shell of the *Nautilus*, which, like many other molluscs, partitions off the disused portion of its dwelling when not required for the accommodation of its soft parts. By this observation Owen brought the growth of Mulluscan shells into close relation, and showed that there is a common character in them all.

One of Owen's most valuable correllations was that of the fibrous hood of the *Nautilus* (composed of the *conjoined* pair of dorsal arms—which are also the *shell-secreting* arms in the Argonaut!) with the conjoined calcareous opercular valves, or *aptychi* of the Ammonite. This was proved beyond a doubt by Dr. S. P. Woodward, in 1860 (see "Geologist," vol. iii., p. 328) by the discovery of an example of *Ammonites subradiatus* with the operculum *in situ*, exactly fitting the aperture of the shell.

In 1856 Owen resigned his connection of twenty years' standing with the Royal College of Surgeons in Lincoln's Inn Fields and entered upon the position of Superintendent of the Natural History Department of the British Museum, to which he had been appointed by Parliament. Here he continued his former scientific researches, and added largely to his palæontological memoirs*. The most

* The Royal Society's list of scientific papers gives the titles of 360 separate papers by Owen *(not his works)*.

valuable of these (to the general reader) was his article "Palæontology" in the "Encyclopædia Britannica" (8th edition, 1860), afterwards printed as a separate volume, and reaching a second edition in 1861. [It is only right, however, to state that Part I., "*Invertebrata*" is from the pen of the late Dr. S. P. Woodward, F.G.S. (author of the "Manual of the Mollusca"), who wrote *the entire original article* and drew the illustrations for the same, but in the second edition passages have been added by Professor Owen to the section *Cephalopoda*. Owen acknowledged his indebtedness in a foot-note, 2nd edition, p. 114.] We refer to it because a contemporary ("Natural Science," January, 1892) has said of Part I. of this very article, "This is *one of the best examples* of Professor Owen's literary power of popular exposition of technical details.

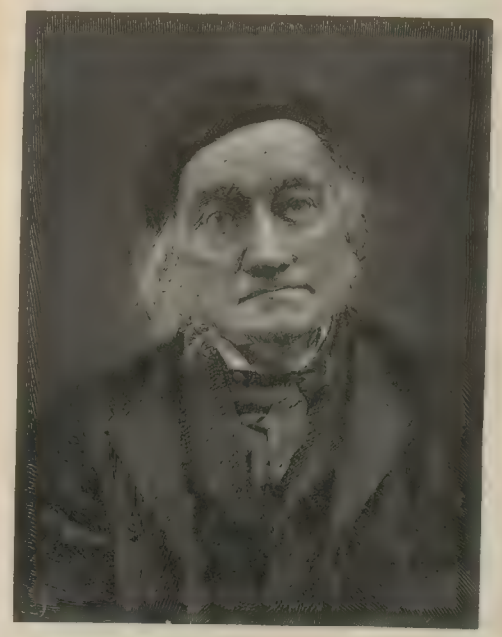
Professor Owen found the Natural History Collections in the old Museum at Bloomsbury, suffering from want of adequate exhibition space, especially the Geological and Mineralogical Collections, which, about that period, commenced to grow in a most alarming manner, being then made into two new and separate keeperships, the former under Mr. G. R. Waterhouse, the latter under Prof. N. S. Maskelyne.

The Recent shells suffered least of all, owing to the fact that they had already acquired *the entire floor-space* of the Ornithological Galleries, and even the accession of Mr. Hugh Cumming's famous collection found space for itself in the numerous cabinets of drawers. But the Mammals, the Osteology, the Insects, Crustacea, &c., the Bird-skins and the collection in spirits of Fishes, Reptiles, &c., suffered all the tortures of "the black hole of Calcutta."

We are indebted to the untiring advocacy of Owen, who, in season and out of season, in his annual reports to Parliament, in his lectures, and in his pamphlets, drew attention to the great loss and inconvenience to science which the Natural History collections suffered in their then restricted rooms. At last, after twenty years' agitation, a building began to arise in the Cromwell Road, which, if not all that one can desire, is at least a "palace of Aladdin" when compared with the "cramped, cabined, and confined" quarters in the old building allotted to Natural History.

As Lord Kelvin said, in his speech on the 21st January, if we owed nothing more to Prof. Owen than the gaining for the nation from its Parliament of such a building for the accommodation of its treasures of Natural History, we may say that he has deserved well of his country, and is entitled to a public memorial.

To tell of Owen's long career, of the honours conferred upon him, at home and abroad, would occupy too much space in this journal. He retired from public life in 1883, three years from the time of the completion of his new Museum. The Queen conferred upon him the honourable distinction of "Knight Companion of the Bath," but "Professor Owen" will always remain his best-known title. He died on the 18th December, 1892, and was buried at Ham, near Richmond, beside his beloved wife.



SIR RICHARD OWEN.

III.—Sir Richard Owen's Researches on the Invertebrata.

In the course of more than half a century's active devotion to scientific research, Sir Richard Owen has investigated the structure of almost every group of living and fossil organisms from man to the internal parasites affecting his frame. His contributions to knowledge of the invertebrated animals are not so numerous as his publications on the living and extinct forms of the vertebrata, but his attention was nevertheless directed successfully in early life to this interesting division of the animal kingdom, and his original memoir on the Pearly Nautilus, published in 1832, when he was only twenty-seven years of age, laid the foundation of his well-deserved fame as a physiological anatomist. Just twelve years later he was awarded the Copley Medal of the Royal Society, in recognition of the merits of a memoir on the fossil "Belemnites" published in the Philosophical Transactions.[10]

The general results of Professor Owen's investigations of the Invertebrata were epitomised in his Catalogues of the Fossil Invertebrata in the Museum of the Royal College of Surgeons, in which more than three hundred and fifty species of fossil cephalopoda collected in the previous century by his famous predecessor in office, John Hunter, were described; in Lectures on the Comparative Anatomy of the Invertebrata, largely based on discourses delivered during his occupancy of the "Hunterian Chair," in that great institution, the foster-parent of so many distinguished reputations; in an article on Cephalopoda contributed to the "Encyclopædia of Anatomy and Physiology," and in that on the Mollusca, including the Molluscoidea, to the eighth edition of the "Encyclopedia Britannica." A remarkable article, entitled "Palæontology" was first published in the latter work, and subsequently enlarged and re-issued as a "Systematic Summary of Extinct Animals and their Geological Relations" in 1861 as a separate publication. (Part I., relating to Invertebrata.) This is one of the best examples of Professor Owen's literary powers of popular exposition of technical details. The Memoir on "Parthenogenesis," treating of the phenomena of asexual generation among certain groups of Invertebrates, belongs more properly to the category of his speculative and philosophical inquiries.

[10] In conjunction with the Memoir on the Monotreme Mammalia.

HUNTERIAN LECTURES

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[*Reported expressly for the "Medical Times," and revised by the Lecturer.*]

LECTURE XVII.

THE METAMORPHOSES OF INSECTS.—Entomological definitions of the coarctate, obtected, incomplete, semi-complete, and complete modifications.—The larva, vermilarva, homomorphous and heteromorphous larvæ—The pupa, mumiæ, chrysalis or aurelia, nymph—The imago—The true character of these defined stages and varieties—Metamorphosis a course of development alike in its essentials, with its stages varied as to time and place: all insects at first vermiform: larval types of Entozoa, Earth-worms, Nereids, Myriapods and Crabs—Metamorphosis and development of organs in Lepidoptera—Economy of social Hymenopters, and of the parasitic Ichneumones and Strepsiptera—Reproduction of parts: Mr. Newport's experiments—Comparison of insect-metamorphoses with mammalian phases of embryonic development.

MR. PRESIDENT AND GENTLEMEN,—I cannot introduce my concluding observations on the generation and development of the class of insects in better language than in the words of our celebrated countrymen, Kirby and Spence, the entomologists to whom we owe the most useful and popular introduction to their delightful science. They say:—

"Were a naturalist to announce to the world the discovery of an animal which, for the first five years of its life, existed in the form of a serpent; which then, penetrating into the earth, and weaving a shroud of pure silk of the finest texture, contracted itself within this covering into a body without external mouth or limbs, and resembling, more than anything else, an Egyptian mummy; and which, lastly, after remaining in this state without food and without motion for three years longer, should, at the end of that period, burst its silken cerements, struggle through its earthly covering, and start into day a winged bird,—what think you would be the sensation excited by this strange piece of intelligence? After the first doubts of its truth were dispelled, what astonishment would succeed! Amongst the learned, what surmises! what investigations! Amongst the vulgar, what eager curiosity and amazement! All would be interested in the history of such an unheard-of phenomenon; even the most torpid would flock to the sight of such a prodigy."(a)

Now, a prodigy of this kind, in all its essential features, is manifested in this country under a thousand modifications. You will witness it, if you trace the life of the common beetle from the egg, or watch the same course of changes in the silkworm.

The first form under which insects appear after quitting the ovum is called the *larva*, a name devised by Linnæus, to signify that beneath this worm-like or snake-like guise there was marked a higher form. The second stage is the *pupa* or *chrysalis;* and the third and last stage is the *imago*, as being the image to which all the former stages tended. Linnæus gave, also, precise terms to the different conditions of the pupa state of the insect; and these terms have been applied by some entomologists to characterise metamorphoses generally. When the last larval skin or sheath of the pupa shows no signs whatever of the limbs or appendages of the creature within it, Linnæus called it a "coarctate pupa." When the pupa-case shows, as if by a kind of sculpture in relief, the character of the organs beneath it, the pupa is "obtected." When the pupa-case forms a special sheath for all the projecting parts and appendages, the pupa is "incomplete."

In all insects the development of the embryo proceeds, with a few secondary and unimportant modifications, in the order which was described and illustrated at the close of the preceding Lecture. The subsequent changes of the insect consist in the growth of all the parts, which takes place chiefly during the period of the moult, and in the gradual acquisition of the wings, which are developed, either when the insect has reverted to the passive state analogous to that of the ovum, as in the kinds of pupa above defined; or the development of the wings, as, *e.g.*, in the *Hemiptera* and *Orthoptera*, is not attended with any loss of activity or diminution of voracity.

The successive states of an apodal worm, of a worm with feet, and of one with feet and wings, being accompanied likewise with the acquisition and perfection of the antennal and visual organs of sense, and of the internal and external organs of generation, and often with great changes in the digestive, muscular, and nervous systems, in the development of one and the same insect, have been emphatically termed "metamorphoses." And entomologists, availing themselves of the neat definitions of the pupæ by Linnæus, have defined various kinds of metamorphoses under special heads, as the "coarctate," "obtected," "incomplete," "semi-complete," and "complete" metamorphoses.

The progress of the insect through these several stages being in many species interrupted, and active life enjoyed for a longer or shorter period under one or other of the immature forms, these have been sooner and more prominently brought under the notice of the naturalist, than if they had had to be sought for, as in the bird or mammal, in the early periods of the development of the minute embryo. They have consequently had assigned to them a character of singularity and exception which they do not intrinsically deserve. The different stages of development have been likewise, for the most part, studied only in the instances in which they are manifested by insects after exclusion from the egg, and thus their minor modifications and differences have attracted more attention than their essential resemblances and relations to one and the same type and course of development.

As soon as the young insect breaks through the egg-shell it is called, in Entomology, a *Larva*, whatever grade of development it may have attained *in ovo*. During the period when it acquires the wings, and until their complete acquisition, it is called a *Pupa*.

From the importance which has been assigned, in some estimable entomological treatises and classifications, to the developmental changes of insects, and the special denominations that have been multiplied to express them, you might suppose the "complete," the "semi-complete," the "incomplete," the "obtected," and "coarctate" metamorphoses, to be different degrees, if not distinct kinds of transformations. But the insects which are said to be subject to the semi-complete and incomplete metamorphosis pass through the same kind and amount of change as those characterised by the obtected or coarctate pupa. The differences resolve themselves essentially into the place where, and the time in which, they assume and quit the vermiform state.

The Orthopterous and Hemipterous insects, characterised in entomology by a semi-complete metamorphosis, are, at one stage of their development, apodal and acephalous larvæ, like the maggot of the fly; but instead of quitting the egg in this stage, they are quickly transformed into another, in which the head and rudimental thoracic feet are developed, to the degree which characterises the hexapod larvæ of the *Carabi* and *Petalocera:* the thorax is next defined and the parts of the head acquired, at which stage of development the young Orthopteran corresponds with the hexapod antenniferous larva of the *Meloe;* but it differs from both these kinds of Coleopterous larvæ in being inactive and continuing in the egg almost until all the proportions and characters of the mature insect are acquired, save the wings.

Oddly enough that development is called "a complete metamorphosis," which is permanently arrested at the stage in which the orthopterous insect enters life, and the only hexapod insects, as the apterous *Cimex* and *Pediculus*, in which the metamorphosis is never completed, are those in which it is said to be "complete." Burmeister, however, seems to be the only Entomologist who has pointed out the inaccuracy of the Fabrician definition; but he failed to free himself from the thraldom of words when he supposed that, in the development of any insects, there was, "properly speaking, no change of form, but merely a repeated casting off of the exterior skin."

With regard to the terms incomplete, obtected, and coarctate, they indicate, in fact, comparatively unimportant modifications of the last moulted skin of the larva of those insects which are torpid or quiescent at the period of the development of the wings. In the bee and beetle, and all *Hymenoptera* and *Coleoptera*, the legs, wings, and antennæ bud out and carry with them processes of the last larval integument, which thus forms in the pupa special sheaths for each growing organ of sense or locomotion in the perfect insect, and which organs are therefore comparatively free, although the pupa be quiescent. Lamark called such pupæ "Mumiæ."

In the obtected Lepidoptera the growing wings, antlia, antennæ, and thoracic legs are only partially covered by the pupal integument, being lodged in recesses on its inner surface, which make corresponding projections on its exterior, where their form and position may thus be recognised.

In the coarctate metamorphosis of the Diptera, the larva sheds its last skin before the growing legs and wings have impressed their forms upon it, and the exuvium constitutes an egg-shaped horny case, upon which there is not the least indication of the parts of the perfect insect.

Under whatever form the insect be excluded from the egg, if we trace its development further back, we shall find that the tendency of the mysterious

(a) "Introduction to Entomology," Vol. I., letter iii. p. 59.

We will now refer briefly to some of the most important of Professor Owen's publications on invertebrates, grouping them for convenience more in zoological order than chronological sequence. Observations on the structure of a new genus of "well-woven" sponge *Euplectella aspergillum*, Owen, appeared in 1841; and in 1857 a new species of the same interesting genus was described. "The threads of the *Euplectella* were not first spun and then interwoven," he wrote in his second memoir on the genus, "but were formed as interwoven, the two processes going on simultaneously; or *pari passu*, in the living state, the exquisite structure of the flinty framework may be veiled by the delicate, gelatinous, enveloping, organic tissue."

No less than five memoirs on the Entozoa appeared in the first volume of the Transactions of the Zoological Society issued in 1836, and his comprehension of "the structural differences existing among them" induced him to propose a more natural classification of this difficult group. His descriptions and figures of a new endo-parasite, first discovered by Mr. (now Sir) James Paget, his fellow student, at St. Bartholomew's Hospital, infesting the voluntary muscles of a human subject, and the subsequent recognition by Zenkrer of *Trichina spiralis*, Owen, as the cause of a troublesome and often fatal disease now known as Trichinosis, led to results of practical utility to mankind.

An interesting paper, entitled *Protichnites*, was published in 1852, wherein the fossil footprints of ancient crustaceans were tracked in the sands of time. "Old Nature speaks as plainly as she can do by these distinct symbols, and if we do not fully thereby read her meaning, the fault is in our powers of interpretation. The creatures which have left their impressions on the most ancient of known sea shores belonged to an articulate and probably crustaceous genus, and *Limulus* comes the nearest to my idea of the kind of animal which has left the impressions on the Potsdam Sandstones." Twenty-one years later Professor Owen published an elaborate and well-illustrated memoir on that interesting, abnormal, but mis-named arthropod, the King-Crab (*Limulus polyphœmus*), which is no crab, and has since been definitely promoted out of the class of water-breathing Crustacea into that of the air-breathing Arachnida and associated with the Spiders and Scorpions.[11] He detailed the muscular, nervous, digestive, and generative systems, and proposed the term "Cephaletron" for the anterior division of the body, and "Thorocetron" for the second; while he declared "the chief fossorial agent, as indicated by the size and disposition of the principal muscular masses, to be the cephaletral digging-shield." While recognising some of the Arachnid affinities of the King-Crab as then maintained by Strauss-Durckeim and Latreille, Owen did not admit the necessity for removing the genus from the order of Merostomatous Crustaceans.

[11] "Limulus an Arachnid," by E. Ray Lankester, F.R.S. *Quart. Journ. Micros. Sci.*, 1881.

Professor Owen's numerous memoirs on the anatomy of the Brachiopoda were second only in importance to his researches on the Cephalopoda. In both classes he founded orders which have been generally[12] accepted by biologists, and still maintain their position as recognised additions to zoological nomenclature and classification. In the article on "Mollusca," published in the eighth edition of the "Encyclopedia Britannica," the sub-kingdom Mollusca was divided into the *Heterogangliata*, with one nerve ganglion, and the superior *Homogangliata* of Owen. The group was compared to a tree, with the Cephalopoda at the summit, one of the roots appeared to be lost in the Turbellarian and the Trematode families of Abranchiate Vermes; the Brachiopoda conducted to the Bryozoa, and both, with the Tunicata, were considered as "mollusc-like" rather than molluscan. The Brachiopoda were regarded as a class equivalent in value to the Lamellibranchiata, and were placed between those acephalous molluscs and the sea-squirts, that is to say, between the "Acéphales testacées," and the "Acéphales sans coquilles" of Cuvier. In 1833 the anatomy of the "Cuvierian genera of Brachiopoda," more especially of *Terebratella* and *Orbicula* (now known as *Discina*), were described. The circulatory, muscular, and nervous systems of other genera were more fully investigated twenty years later, and the results published, accompanied by beautiful drawings by the author, in a "Memoir on the Anatomy of Terebratula," in the Introduction to Davidson's classical Monograph of the "British Fossil Brachiopoda," elucidating some points in the structure of *Waldheimia* and *Lingula*. Owen's brachiopodal hearts are now known to be oviducts, and it has since been made evident that he did not recognise the closure of the intestine in certain genera—a physiological feature of ordinal value. But he divided the class into two orders, so well differentiated by other characters, that the names of *Lyopomata* (or loose valves) and *Arthropomata* (or jointed valves), which he applied to them respectively, should retain priority over the *Articulata* and *Inarticulata*, the *Tretenterata* and *Clistenterata* of other investigators, of which subdivisions they are the exact equivalents. Owen's researches on the internal structure of the Brachiopoda marked a distinct advance in knowledge of this difficult and obscure group of organisms.

In a memoir on the anatomy of *Clavagella*, Professor Owen noted the enormous development of the mantle in the "club shells" as one of the instruments in the work of excavation for which these bivalves are remarkable. Some observations on the camerated structure in the valves of the water-clam (*Spondylus varius*) were first

[12] Waagen and F. A. Bather excepted. Mr. A. H. Foord, in his exhaustive "Catalogue of the Fossil Cephalopoda in the British Museum," 1888 (p. viii., Int., part i., Order Nautiloidea), states that "no evidence has as yet been brought forward that the fossil forms included by Owen in the Tetrabranchiata were other than four-gilled."

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In the obtected Lepidoptera the growing wings, antlia, antennæ, and thoracic legs are only partially covered by the pupal integument, being lodged in recesses on its inner surface, which make corresponding projections on its exterior, where their form and position may thus be recognised.

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(a) "Introduction to Entomology," Vol. I., letter iii. p. 59.

printed in the *Proceedings of the Zoological Society* for 1837, when attention was directed to the chambered and septated condition of the shell in that genus, and to the connection existing between the mode of growth in *Nautilus* and that of other molluscs which partition off a part of their shell not required for the convenience of the soft parts of the animal inhabiting it. It was then distinctly stated that the septal divisions of the *Nautilus* shell are analogous to the septa of the "water-spondylus," and many other shells which partition off the disused portion of their houses both among univalves and bivalves. An investigation of the anatomy of the gasteropod family of the "bonnet-shells" (Calyptreidæ) proved of interest "as manifesting some of the successive stages of complexity in the passage from the simple *Patella* to the spiral valves." Professor Owen's studies of the univalve mollusca in general, and of the recent *Nautilus* in particular, led him to the conclusion that the Pteropoda had less affinities with the Dibranchiate, or "two-gilled" cephalopoda, than the recent *Nautilus*. This form he considered to be the type of an inferior order of tetrabranchiate, or "four-gilled" cephalopoda, represented by numerous fossil species, and as an osculant form between the cephalopoda and gasteropoda. In consequence of this conviction, he transferred the encephalous floating Pteropoda from above to below the Gasteropoda[13] in his classification of the Mollusca, which is based chiefly on the conditions of the respiratory organs, as a physiological character intimately connected with activity of locomotive functions.

The subject of the Pearly Nautilus had been strongly recommended to his attention by Baron Cuvier, in whose dissecting rooms young Owen enjoyed the privilege of working. The famous French zoologist had never seen a specimen of the animal of this genus, which was known to Aristotle, and had been briefly described by Rumphius. It was, therefore, with peculiar satisfaction that Mr. Owen received an example in alcohol which had been captured, in a dying condition, by his friend and former fellow-student at the College of Surgeons, Dr. George Bennett of Sydney, while cruising in the Polynesian seas. The results of his investigations appeared in the "Memoir on the Pearly Nautilus, with illustrations of its external form and internal structure," which, to the keen regret of the author, was not issued from the press until three days after the death of his illustrious master. The animal was shown to be characterised by the presence of pedunculated eyes, calcareous mandibles, like a bird's beak reversed, a crop, gizzard, and liver, four gills, or breathing organs, and by the absence of a branchial heart and ink-bag. It occupied the last and largest chamber of a nacro-porcellanous, many-chambered shell, into the last cell of which it could retract itself and its numerous simple non-aceptabulated arms closing the mouth of

[13] The Pteropoda are now considered to belong to the inferior branch of the class Cephalopoda by those who place the class Gasteropoda at the summit of the Molluscan series.

the shell by the dorsal arms and by a horny hood-shaped structure, the analogue of the aptychi or double operculum of the fossil Ammonite. A central siphuncular tube pierced all the septa running through all the chambers or so-called "air-cells" which had been occupied by the animal in succession. This siphuncle "subserved a hydrostatic function," enabling the animal to rise to the surface and sink to the bottom, possibly by means of a gas secreted from the mantle. But the author's remark that "much remains to be done before the theory of the chambers and siphuncle can rest on the sound basis of experiment and observation" is still applicable.[14] The order Tetrabranchiata was proposed to receive the recent *Nautilus* characterised by the presence of four gills, a many-chambered external shell, and the absence of an ink-bag; and the fossil Ammonites and their allies were included therein. The Dibranchiata comprised all the two-gilled naked Cephalopods with an internal shell, or pen, and an ink-bag such as the living octopoda, the squids, cuttles, and the fossil Belemnitidæ.

In 1844 Professor Owen resumed the study of fossil cephalopoda, and communicated descriptions and figures of "certain Belemnites preserved with a great proportion of their soft parts in the Oxford Clay at Christian Malford, Wilts." The guard sheath or rostrum, known as the dart or javelin, whence the name Belemnite was originally applied, was described; the chambered or vertically septated portion was named the phragmacone; while the presence of an ink-bag, internal shell, muscular mantle, and aceptabulated arms were duly noted, and the fossil molluscs were classed with the recent *Spirula*, in the order Dibranchiata. The examples of *Belemnites oweni* upon which this memoir was founded, were subsequently shown by later investigators to belong to the animal of *Belemnoteuthis*, an extinct member of the existing squid family, and the animal of the true Belemnite proved to be characterised by the presence of an internal pen or pro-ostracum not found associated with the fossil remains of *Belemnoteuthis*.

In the same year Professor Owen communicated to the Zoological section of the British Association two papers detailing the "Further Experiments and Observations on the *Argonauto argo*," by Madame Jeannette Power, the originator of marine aquaria. He prefaced them with some remarks on the relation of the animal of the Paper Nautilus to its shell. The experiments which proved that the dorsal arms were the fabricants of the shell instead of the mantle, as in the Pearly Nautilus, had been suggested to Madame Power by Professor Owen. He has also described *Rossia*, a sub-genus of *Sepiola* (*R. palpebrosa*, Owen). In 1848 he enjoyed an opportunity of dissect-

[14] There appears to be no doubt that the deserted chambers of the *Nautilus*-shell contain, in the healthy living animal, a gas which serves to lessen the specific gravity of the whole organism . . . . "A certain stage is reached when no new chamber is formed; with regard to its origin we can only conjecture; the whole matter is involved in obscurity." Ray Lankester, ninth ed., Ency. Brit., 1883.

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LECTURE XVII.

THE METAMORPHOSES OF INSECTS.—Entomological definitions of the coarctate, obtected, incomplete, semi-complete, and complete modifications.—The larva, vermilarva, homomorphous and heteromorphous larvæ —The pupa, mumiæ, chrysalis or aurelia, nymph—The imago—The true character of these defined stages and varieties—Metamorphosis a course of development alike in its essentials, with its stages varied as to time and place: all insects at first vermiform: larval types of Entozoa, Earth-worms, Nereids, Myriapods and Crabs —Metamorphosis and development of organs in Lepidoptera—Economy of social Hymenoptera, and of the parasitic Ichneumones and Strepsiptera—Reproduction of parts: Mr. Newport's experiments—Comparison of insect-metamorphoses with mammalian phases of embryonic development.

MR. PRESIDENT AND GENTLEMEN, — I cannot introduce my concluding observations on the generation and development of the class of insects in better language than in the words of our celebrated countrymen, Kirby and Spence, the entomologists to whom we owe the most useful and popular introduction to their delightful science. They say:—

"Were a naturalist to announce to the world the discovery of an animal which, for the first five years of its life, existed in the form of a serpent; which then, penetrating into the earth, and weaving a shroud of pure silk of the finest texture, contracted itself within this covering into a body without external mouth or limbs, and resembling, more than anything else, an Egyptian mummy; and which, lastly, after remaining in this state without food and without motion for three years longer, should, at the end of that period, burst its silken cerements, struggle through its earthly covering, and start into day a winged bird,—what think you would be the sensation excited by this strange piece of intelligence? After the first doubts of its truth were dispelled, what astonishment would succeed! Amongst the learned, what surmises! what investigations! Amongst the vulgar, what eager curiosity and amazement! All would be interested in the history of such an unheard-of phenomenon; even the most torpid would flock to the sight of such a prodigy."(a)

Now, a prodigy of this kind, in all its essential features, is manifested in this country under a thousand modifications. You will witness it, if you trace the life of the common beetle from the egg, or watch the same course of changes in the silkworm.

The first form under which insects appear after quitting the ovum is called the *larva*, a name devised by Linnæus, to signify that beneath this worm-like or snake-like guise there was marked a higher form. The second stage is the *pupa* or *chrysalis;* and the third and last stage is the *imago*, as being the image to which all the former stages tended. Linnæus gave, also, precise terms to the different conditions of the pupa state of the insect; and these terms have been applied by some entomologists to characterise metamorphoses generally. When the last larval skin or sheath of the pupa shows no signs whatever of the limbs or appendages of the creature within it, Linnæus called it a "coarctate pupa." When the pupa-case shows, as if by a kind of sculpture in relief, the character of the organs beneath it, the pupa is "obtected." When the pupa-case forms a special sheath for all the projecting parts and appendages, the pupa is "incomplete."

In all insects the development of the embryo proceeds, with a few secondary and unimportant modifications, in the order which was described and illustrated at the close of the preceding Lecture. The subsequent changes of the insect consist in the growth of all the parts, which takes place chiefly during the period of the moult, and in the gradual acquisition of the wings, which are developed, either when the insect has reverted to the passive state analogous to that of the ovum, as in the kinds of pupa above defined; or the development of the wings, as, *e.g.*, in the *Hemiptera* and *Orthoptera*, is not attended with any loss of activity or diminution of voracity.

The successive states of an apodal worm, of a worm with feet, and of one with feet and wings, being accompanied likewise with the acquisition and perfection of the antennal and visual organs of sense, and of the internal and external organs of generation, and often with great changes in the digestive, muscular, and nervous systems, in the development of one and the same insect, have been emphatically termed "metamorphoses." And entomologists, availing themselves of the neat definitions of the pupæ by Linnæus, have defined various kinds of metamorphoses under special heads, as the "coarctate," "obtected," "incomplete," "semi-complete," and "complete" metamorphoses.

The progress of the insect through these several stages being in many species interrupted, and active life enjoyed for a longer or shorter period under one or other of the immature forms, these have been sooner and more prominently brought under the notice of the naturalist, than if they had had to be sought for, as in the bird or mammal, in the early periods of the development of the minute embryo. They have consequently had assigned to them a character of singularity and exception which they do not intrinsically deserve. The different stages of development have been likewise, for the most part, studied only in the instances in which they are manifested by insects after exclusion from the egg, and thus their minor modifications and differences have attracted more attention than their essential resemblances and relations to one and the same type and course of development.

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ing an unique but fragmentary specimen of the animal of *Spirula peronii*, and a portion of *Spirula reticulata*, and contributed the results to the "Zoology" of the "Voyage of H.M.S. 'Samarang.'" Thirty years later he returned to the subject of the structure of this interesting genus.

In 1878 Professor Owen discussed with much vigour "The Relative Positions to their Constructors of the Chambered Shells of Cephalopods." In this paper he showed that the shells of *Nautilus* and ammonites are revolutely spiral, or coiled over the back of the animal, not involute like the *Spirula*, and maintained the opercular character of the aptychi, which had been doubted by Keferstein and Waagen. He reiterated the opinion that they correspond to the fibrous hood of *Nautilus pompilius*, and are the calcifications of an ammonite hood. The fact that no trace of the ink-bag has ever been found with any fossil ammonite although that organ occurs abundantly in the fossil Belemnitidæ, is cited as conclusive evidence that the Ammonites were tetrabranchiates protected by an external shell, and he points out that the occurrence of the protective ink-bag in the *Spirula* proves that mollusc to belong to the more active dibranchiate order, with an internal chambered shell—the homologue of the phragmacone of the Belemnite.

The ink-bag does not occupy the last chamber of *Spirula*, as had been maintained in Woodward's "Manual of the Mollusca." The situation of the small pyriform ink-bag in that genus being "rectal," as Owen first demonstrated in 1848. It is denied that the septated condition of the many-chambered shells of the *Nautilus* was related conditionally to the generative function and periodical increase, as had been asserted by Professor Seeley and by Dr. Henry Woodward, for the reason that the formation of such chambers commences from the embryonal cup ("protoconch") and continues through an early period of growth antecedent to the acquisition of the procreative functions, or the adult stage of existence, and that these early chambers are relatively deeper than the succeeding ones.

In this comprehensive review of the subject Professor Owen states that he "holds by the opinion expressed in his original memoir and in the 'Catalogue of the Fossil Cephalopoda in the Hunterian Museum' (4th ed., 1856, p. 29), that they so affect the specific gravity of the active, highly-organised, cephalopodous mollusc, as to enable it with little èffort to rise, in the case of the *Nautilus*, from its habitual position at the bottom of the sea, and in the case of the *Spirula*, to sink from its more usual zone at or near the surface, by means of the hydrostatic mechanism worked by the muscular forces of the mantle and funnel. The constancy of the siphuncular connection running through all the chambers of the largest and most complex of the polythalamous shells, with the great size and singular complexity of the siphuncle in several extinct species, form the grounds on which I still hold to my original belief in the function

of the siphuncle as related to a maintenance of the vitality of the shell."

In the following year, Professor Owen published the results of his dissections of a perfect specimen of *Spirula australis* received from Mr. Cuming. The animal was described as almost as devoid of external organs of natation as *Nautilus*. In both, the direction in which such forces act is retrograde. *Nautilus* exercises them mainly by virtue of the muscular funnel, through which it forcibly ejects into the surrounding water the respiratory current. *Spirula* superadds to this the ejection of that volume of water upon which the cephalic arms and their basal webs contract after the fashion in which the other Dibranchiata, especially the Octopods, propel themselves backwards. *Spirula* is superior to *Nautilus* in the cephalic mechanism. In both instances of multilocular cephalopods, the natatory power is inferior to that of existing Dibranchiata. The distinction, therefore, between *Nautilus* and *Spirula* in regard to the shell in its protective relation is relative not absolute: in the one a small proportion of the shell is occasionally "internal," in the other a small proportion is always "external," in both the multilocular shells correspond with the phragmacone of the Belemnite. The tetrabranchiate *Orthoceras* may be called a representative analogue of the dibranchiate Belemnite, as the tetrabranchiate Ammonite is of the dibranchiate *Spirula*. The siphon is "ventral" and marginal in both kinds of coiled shells, but it runs along opposite sides of the coil. In *Spirula*, its position is internal, or ento-marginal; in ammonites, it is external or "ecto-marginal."

In 1883 the veteran anatomist published a paper on the "Aspect of the body in Vertebrates and Invertebrates," which formed, we believe, his last contribution to the anatomy of the invertebrated animals. His researches cover a period of fifty years and afford constant proof of the patience, industry, and acumen of the author. "The progress of Palæontology since 1830," he wrote in 1866, "has brought to light many missing links unknown to the founder of the science. My own share in the labour led me, after a few years of research, to discern what I believed, and still hold to be, a tendency to a more generalised or less specialised organisation as species recede in date of existence from the present time."

AGNES CRANE.

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With regard to the terms incomplete, obtected, and coarctate, they indicate, in fact, comparatively unimportant modifications of the last moulted skin of the larva of those insects which are torpid or quiescent at the period of the development of the wings. In the bee and beetle, and all *Hymenoptera* and *Coleoptera*, the legs, wings, and antennæ bud out and carry with them processes of the last larval integument, which thus forms in the pupa special sheaths for each growing organ of sense or locomotion in the perfect insect, and which organs are therefore comparatively free, although the pupa be quiescent. Lamark called such pupæ "Mumiæ."

In the obtected Lepidoptera the growing wings, antlia, antennæ, and thoracic legs are only partially covered by the pupal integument, being lodged in recesses on its inner surface, which make corresponding projections on its exterior, where their form and position may thus be recognised.

In the coarctate metamorphosis of the Diptera, the larva sheds its last skin before the growing legs and wings have impressed their forms upon it, and the exuvium constitutes an egg-shaped horny case, upon which there is not the least indication of the parts of the perfect insect.

Under whatever form the insect be excluded from the egg, if we trace its development further back, we shall find that the tendency of the mysterious

(a) "Introduction to Entomology," Vol. I., letter iii. p. 59.

multiplication, arrangement, and transformation of the hyaline nucleus and germ-cells is vermiform. In all insects the embryo first manifests itself as an apodal smooth Entozoon; next as an Annellide of thirteen rings: in all insects the first segment is quickly modified and the mouth established; and in this state the larva is excluded in some insects, as the bee and fly, without any appendages being developed; and in the bee before the completion of the intestinal canal.

The maggots of the order *Diptera* and *Hymenoptera* typify the Entozoa; they have no distinct scaly head, and no thoracic legs; hence they have been termed "vermilarves." Those of the *Diptera* and of the *Ichneumonidæ* represent the parasitic worms, not only in structure, but in habits; the larvæ of the *Gastorophili* called "bots," pass that stage of their existence in the alimentary canal of higher animals. The larva of the *Anthorugia caniculuris* may be, in like manner, considered as entozoa of the human subject. There is a breeze-fly (*Œstrus hominis*) which deposits its egg beneath the integument of the living body, and its larva there grows and flourishes like the Filaria in the cellular tissue. The larva of a species of *Cuterebra* occasionally finds its way into the human frontal sinus. Other vermilarves, as those of the *Œstri Bovis* and *Tarandi*, are developed beneath the integument or in the nasal sinuses of the Ruminants indicated by their specific names. I know not to what other modes of animal life than that of the parasitic Entozoa we can compare the habits of the voracious maggots of the flesh-fly, the essential condition of whose existence is the putrid flesh of higher organised beings. Here, however, the development of helminthoid larva has been beneficially ordained in order to neutralise the noxious effects of the otherwise inevitable processes by which dead animal matter reverts to its primitive elements. Insignificant, indeed, do these larvæ seem to be in the scale of nature, yet Linnæus used no exaggeration when he averred that three flesh-flies would devour the carcase of a horse as quickly as would a lion. The assimilative power is so great in the meat-maggot that it will increase its own weight two hundred times in twenty-four hours.

But the developmental energies are not exhausted by the rapid growth of the larva; some remain to be exercised in the formation of the new and peculiar organs which entirely change the form and properties of the creature. For this exercise they usually require the suspension of all the ordinary actions of life. The larval skin is thrust off by the new integument of the new organs, and is converted into an opaque brown case; the enclosed insect shrinks partly by the loss of exhaled fluids, partly by the condensation of its former soft tissues into the new and firm substances constituting the legs and wings. A large and distinct head is now developed, with eyes, antennæ, and instrumenta cibaria; all which processes are carried on in the quiescent concealment of the opaque and dark exuvium, like the analogous processes in the egg of the oviparous, and within the womb of the pupiparous, insect. The active carnivorous vermilave returns, in fact, a second time to the state of an ovum, when it becomes the coarctate pupe; and the perfect insect, splitting its cerement, issues forth as by a second birth.

The larvæ of the gnats (*Culex*) and crane-flies (*Tipulæ*) have a distinct corneous head with jaws; the former have a plumose anal coronet, by which they sustain themselves at the surface of the water; the orifices of the tracheæ are placed in the middle of this coronet. A pair of tracheal tubes extend through the long, slender, and extensile anal canal of the aquatic grub of the *Musca* (*Eristalis*) *tenax*. By this mechanism, which is analogous to the tube of the diving-bell, the rat-tailed larva can derive its requisite supply of air from the surface while groping for food in the mud at the bottom of the pool.

The economy of the Hymenoptera and the various circumstances attending the development of their apodal larvæ form the subjects of a long chapter in the History of Insects.

I must be governed in the unavoidably brief selection from this rich storehouse of interesting facts by the specimens which Hunter has left for our instruction. Here (exhibiting the preparation No. 3104) we have a portion of the nest of a social hymenopterous insect of the wasp tribe (*Polistes major*), showing the larvæ and their cells in every stage of growth; the smallest larvæ and the shallowest cells are at the lower margins of the pendent nest; and observe how, in these beginnings of cells, the part of the incomplete circumference forms two, three, or more sides of a complete hexagon, demonstrating that this is the form of cell originally and expressly made by the insect, and not the accidental and inevitable result of the reciprocal pressure of originally cylindrical cells, moulded upon the bodies of their simultaneously-working fabricators. The parent wasp of this colony began her labours in spring. A solitary mother and independent builder of the required shelter for her offspring, she herself nursed and fed her first brood, which, being non-breeding labourers, soon aided their parent in building the cells and rearing her larvæ. You will observe that the full-grown grubs, which require no more food, and are about to fall into the pupa state, are shut in by a transparent convex pellicle, which covers the mouth of the cell.

In the common wasp, the larva is hatched eight days after oviposition; it grows to its full size in twelve to fourteen days, then spins its delicate hood, casts its integument, which has grown with its growth from the time of quitting the egg, and, after a passive pupa state of ten days, emerges a perfect insect. The males and perfect females are reared at the beginning of autumn; the abundance of food yielded by the ripe fruit at that season may influence the higher development of the larvæ, which are fed by the regurgitated contents of the crop of the nursers.

The fertile females share with the non-breeders or neuters of the rapidly increasing community, the labour of rearing the young broods; the males, or drones, perform no kind of work. At the close of autumn, when provender is scanty, and hardly to be got, the neuters, by a strange, and, as it would seem, perverted instinct, save the later brood of grubs from the pangs of famine by killing and casting them out of the nest. The young females are impregnated previous to the setting in of winter; the males soon after die; the females then disperse, seeking winter quarters in sheltered situations; and those which survive the rigours of the frosty season commence, at the return of spring, the foundation of a new colony.

The higher instincts of the honey-bee (*Apis mellifica*) teach it to lay up a winter store of food, upon which, the males having been destroyed on the performance of their sole office, the queens, with a family of neuters, subsist till spring. The neuters alone now recommence their labours of housing, in waxen cells, the eggs of the fertile female, and feeding the larvæ. New colonies so raised successively emigrate from the parent hive, or "swarm"; they consist of a queen or fertile female, and perhaps a thousand attendant neuters. Thus the association, which is annually dissolved and re-commenced by the wasps, is permanent in the honey-bee, and the fertile female, or queen, never shares with the neuters the labours of the hive.

The development of the bee is more speedy than that of the wasp; the larva is hatched in three days after the exclusion of the egg; it feeds and grows five or six days; is then shut up by the workers, spins itself a cocoon in thirty-six hours, remaining a passive pupa eight or nine days; then breaks through the lid and emerges in its perfect state. Thus the whole period of development from the exclusion of the ovum is from eighteen to twenty days; this, however, relates to the neuter. The male or drone larva spends only twenty-four hours in spinning its cocoon, and emerges on the sixteenth day after its deposition as an egg. A young queen is perfected on the twenty-fourth day. It is remarkable, that the larva of the bee and of the parasitic Hymenoptera have no anal outlet; no fæces are passed until the larva has acquired full growth, and has ceased to feed, preparatory to the pupa-state: thus the fluids of insects infested by the parasitic larvæ are not contaminated by the excrements of their parasites; and the bee-cells are kept sweet and clean during the active life of the larva.

In these preparations (Nos. 3117 to 3123 inclusive) are shown the irregular subelliptical cells with the larvæ and perfect insects of the humble bees (*Bombi terrestris* and *lapidarius*). The societies of this genus, which consist of about sixty, and occasionally of 200 individuals, continue, as in the wasp-tribe, only until the beginning of winter, and the few impregnated females which survive the frosts found fresh colonies at the commencement of the following spring. The fertile female shares in the labours of the community which she has originated, and she is provided, like the neuters, with the dense fringe of hair surrounding the pollen plate of the hind legs, which the queen of the hive-bee does not possess. The first progeny of the humble-bee are neuters; the males are not developed until autumn, and they are the produce of a smaller kind of fertile female. The whole economy of the humble-bee was very completely observed by Hunter, whose MS. notes on this subject have been published in the fifth volume of the Physiological Catalogue.

The larvæ of the Coleoptera are active, although some, as the nut-weevil, are apodal, like the larvæ of the bee. In most of the herbivorous species the thoracic legs are represented by fleshy tubercles; but the larvæ of the carnivorous beetles have the thoracic legs more completely developed before quitting the ovum. The head is horny, and the trophi are well developed in all: the jaws frequently resemble those of the perfect insect, as in the *Carabidæ*, the larvæ of which likewise have antennæ.

The circumstance of most physiological interest in the development of the Coleopterous order of insects is the great length of time during which the species actively exist in the vermiform or larval stage of their development. The larvæ of the cock-chafer typify the earth-worm in their habits, and continue for three years burrowing in the soil and devouring the roots of grass and other vegetables. The larva of the stag-beetle bores its way into the trunk of a tree, generally a willow or oak, and remains there six years. It is furnished with two powerful jaws, with which it gnaws the wood. It forms a cocoon of the minute chips or tan, to which it reduces the wood, and passes a considerable period in the pupa state; during which, the large horns of the male are folded upon the breast and abdomen, protecting the antennæ and legs.

The anatomy of an insect in its different stages of development, and the changes of both the external and internal parts in the progress from the larva to the imago state, have been most accurately and closely examined in Lepidopterous insects. Many of these changes are shown by Hunter, in his extensive series of preparations of the silkworm moth. They were investigated by Lyonnet in the *Cossus ligniperda*. They have been described and illustrated with much accuracy and detail by Herold in the *Papilio Brassicæ*, and by our own indefatigable entomologist, Mr. Newport, in the *Sphinx Ligustri*, and other insects. The larvæ of the Lepidoptera quit the egg with a scaly head and jaws, with three pairs of thoracic legs, short, and with claws, and usually four pairs of tubercular prolegs, supported by the sixth, seventh, eighth, and ninth segments; sometimes there is also a fifth pair upon the anal segment. The prolegs, which entirely disappear in the pupa, are, however, less constant than the thoracic legs. The larvæ of the Lepidoptera are commonly herbivorous, and devour considerable quantities of vegetable matter. The coarsely masticated leaves are conveyed, by a short and wide œsophagus, to a much longer and wider chylific stomach. Six pairs of capillary bile-tubes indicate, by their insertion, the commencement of the intestine, which terminates by a wide, short, and longitudinally plicated rectum, upon the last segment.

In its perfect state, the butterfly, or sphinx, subsists only on the fluids of vegetables: its maxillary apparatus is converted, by the abrogation of the horny mandibles and the extreme prolongation of the maxillæ, into a long suctorial tube, called "antlia." A long and slender œsophagus conveys the fluids to the chylific stomach, and to a wide crop, which during the pupa state has been gradually expanded from one side of the end of the gullet. The chylific stomach has shrunk into a comparatively short fusiform cavity, which is still characterised by the transverse sacculi and constrictions. The small intestine has diminished in width, but increased in length, and now lies in several convolutions between the chylific stomach and colon, the upper part of which has also been produced into a cæcum.

The biliary vessels are diminished in length, but still communicate, by a short common duct on each side, with the commencement of the small intestine.

In the bee the metamorphosis of the digestive organs is still more striking than in the butterfly, inasmuch as the alimentary cavity consists, beyond the short and wide œsophagus, exclusively of a large transversely plicated chylific stomach without intestine or vent.

The larvæ of bees and wasps have from four to six biliary vessels, which shrink in diameter and contract in length during the pupa state.

The gizzard is never present in the vermiform larvæ of the *Coleoptera*, although usually possessed by the perfect insect.

In the larvæ of the *Scarabæi*, *Melolontha*, and most herbivorous Coleoptera, the chylific stomach is shorter than in the imago; but it is furnished at both ends with cæcal appendages, which disappear during the metamorphosis, except in the genus *Hister*, in which some traces remain in the perfect insect.

The salivary vessels of the caterpillars of the Lepidoptera are of two kinds; one pair is short and broad, sometimes vesicular, as in the *Cossus ligniperda*, and their ducts terminate at the base of the maxillæ. Those of the second pair are very long and slender, occupying, with their longitudinal coils, the sides of the abdomen, and sending their slender ducts forward to unite together and terminate upon a peculiar prominence upon the under lip, which is called the spinneret. (This was shown in the preparations, Nos. 2985 to 2988.) These tubular glands, though classed with the salivary apparatus, are peculiar, in their full development, to the larvæ, and are called "sericteria" or silk-tubes, because they prepare the glutinous material or silk, which the larva spins to form its cocoon. In the perfect insect, the remains of the salivary apparatus are limited to the thorax, and the common duct opens beneath the tongue.

The epithelial lining of the alimentary canal of the larva is shed at each moult; that of the closed stomach in the bee maggot is evacuated in the pupa state through the new formed anus.

The superabundant nutriment prepared by the voracious larva is stored up in the condition of masses of fat which surround the viscera and occupy their interspaces.

The parasitic Ichneumons introduce their ova beneath the skin of the larvæ of Lepidoptera. When hatched the Ichneumon larvæ subsist upon the fat of the caterpillars, which they infest. They avoid penetrating the alimentary canal, but evidently destroy many of the minute branches of the trachea which ramify in the adipose tissue. Such wounded tracheæ probably permit the escape of sufficient air for the respiration of the parasitic larvæ; for though the caterpillars so infested survive and go into the pupa state, they are uneasy, and evidently diseased; the loss of the adipose store of nutriment prevents the completion of the metamorphosis, and instead of a butterfly, a swarm of small Ichneumons emerges from the cocoon.

With respect to the outward form and integuments of the vermiform larva, these are contracted lengthwise, and partially dilated during the pupa state. The longitudinal muscles contract, and are permanently shortened by interstitial absorption: they shorten the body by sheathing the segments one within the other, the intus-suscepted portions being afterwards modified or removed.

The dorsal vessel, which is developed above the intestine, and begins to pulsate before the larva quits the egg, undergoes a corresponding change with the common integument in the pupa state. It seems to be contracted by a series of intus-susceptions; the abdominal part is slightly expanded, more definitely divided into chambers, and better provided with valves; the thoracic portion is simplified, shrunk in diameter, and is more distinctly defined as an aorta sent off from the heart.

The respiratory system undergoes still more remarkable modifications. The branchiæ of the aquatic larvæ either disappear or are developed into wings: the long pneumatic tubes of those which, living in water, breath air, shrink and disappear. The partial dilatations of certain tracheæ to form reservoirs of air for diminishing the specific gravity of the body, begin to be formed in the pupa state of the flying insect.

Herold has shown that germs of the generative organs exist in the larvæ of the Lepidoptera; the testes appear on each side as four nucleated cells in a longitudinal series, which, by progressive coalescence longitudinally, and by approximating transversely, and ultimately uniting at the middle line, first form an eight-chambered, and afterwards a spherical gland. The ovaria retaining their primitive separate state, increase in length, and assume the spiral disposition in the pupa state.

The progressive changes which the nervous system of the Lepidopterous insect undergoes in its metamorphoses from the larval into the perfect state, have been beautifully and accurately illustrated by Herold, in the cabbage butterfly, and by Mr. Newport, in a species of sphynx; but Lyonnet had anticipated both these observers, in recognising as well the principle as the details of these changes, which he briefly describes at the termination of his immortal monograph on the *Cossus ligniperda*.

The twelve ventral ganglions of the larva are subequal, and, except the two last, at regular distances; in the pupa, the interganglionic columns are shorter, but the body, becoming still more abbreviated and concentrated, throws those columns into curved lines. The eleventh and twelfth ganglions coalesce; the sixth and seventh disappear; the fifth blends with the fourth, and the third with the second; thus leaving four ganglions in the abdomen and two in the thorax. Corresponding changes take place in the cerebral portion of the nervous system. The maxillary ganglion decreases with the diminution and change in the maxillary apparatus. The œsophageal collar contracts, as does the canal which it surrounds. The brain enlarges, having to supply organs of sense, especially those of sight, which are perfected to correspond with the acquisition of new and improved locomotive forces. Analogous changes we may naturally conclude to take place in other orders of insects; and we find, indeed, in some of these, that the nervous system continues stationary at stages of development which are progressive and transitory in the Lepidoptera, and that further concentration is discovered to have taken place in the Melolontha, Cicada, Nepa, &c., than that which constitutes the highest stage observed by Herold and Mr. Newport in the Lepidoptera. The marvel is, that these changes, due in part, apparently, to mere mechanical influences, should be so regular, so orderly, so admirably adapted, in their final results, to the general condition and exigencies of the perfect insect. One might have supposed, that the particles of the soft and semi-fluid nervous matter, squeezed by the pressure of the surrounding structures, when the body seems to be, as it were, contracted by a universal spasm, would be irregularly dislocated or aggregated into one or more masses; but, on the contrary, we perceive the nervous particles moving forwards and re-arranging themselves in orderly groups, definite in their forms, in their proportions, and in their relative positions; these being apparently regulated by a law of prospective arrangement and arranged precisely in those situations where the greatest supply of nervous energy is required to radiate from them in the active and perfect insect.

The general principle of those changes is like that which governs the modifications of the muscular system, viz., a localisation of special masses at particular parts for special purposes, the result of which is the departure from a common to a particular type of arrangement.

One of the most obvious and remarkable phenomena in the larval life of an insect is the successive sheddings of the skin. The number and frequency of the ecdyses varies in different species, and relates to two circumstances, viz., the rapidity of the growth of the body, and the susceptibility or otherwise of the skin to be distended or to grow with the increase of the body.

The soft-skinned maggots of many flies, which acquire a vast increase of size during their brief larval state, never moult until they change into pupæ, when the exuvium forms the pupa-case. In like manner, the soft-skinned apodal larvæ of the Hymenoptera do not moult until they have acquired their full size. The caterpillars of the Lepidoptera moult at least three times, and some more frequently; the *Bombyx villica*, for example, from five to eight times, and the tiger-moth (*Arctia caja*) ten times.

With regard to the nature of the mutations and ecdyses which culminate in the perfect insect, I should hardly have felt justified, after what has been already detailed respecting the development of the larva in the egg, in referring to the hypothesis of Swammerdam,—that the imago was actually included in the larva, and that all new skins pre-existed beneath the old one,—if such opinion had not been adopted to explain the metamorphoses of insects in the admirable work, already cited, of Kirby and Spence, and maintained by Cuvier in the second and posthumous edition of his celebrated "Leçons d'Anatomié Comparee," where, in the sixth volume, p. 2, (1846,) he writes, "des l'instant ou les corps vivants existent, quelque petits qu'ils soient encore, ils ont toutes leurs parties: ce n'est point par l'addition de nouvelles couches qu'ils croissent, mais par le dévelopement de parties toutes pre-existantes à tout accroissement sensible." The accurate observations of Herold on the changes and development of the organs, during the pupa state, show these to be, like the original processes of the development of the larva itself, the results of a transmutation, increase, and coalescence of primitive elements of the different tissues,—elements which consist of nucleated cells or nuclei, like those that result from the spontaneous fissions of the primary impregnated germ-cell,—elements which may be viewed as parts of the original germ-mass, retained to be successively metamorposed into the successive larval skins, pupa-skin, and imago.

The few instances of the reproduction of mutilated parts in insects have been observed to take place only at the period of the mou't, and are never manifested by the imago. A young *Blatta*, in which both the antennæ had been cut off, moulted a fortnight after the operation, and then acquired two new but shorter antennæ: the legs and prolegs of caterpillars are said to be produced in like manner after one or two moultings.

The passive and, as it were, embryonic condition to which most insects (Coleoptera, Lepidoptera, Hymenoptera, Diptera, many Neuroptera) return when, after an active larval life, the organising energies again superinduce the processes of development upon those of mere growth, is called the pupa state. The chief modifications of the pupa have already been explained in relation to the terms coarctate, obtected, incomplete, by which they are designated by Linnæus.

Some pupæ are protected only by the exuvial skin of the preceding stage, and have been termed "naked;" others repose in cases or "cocoons." artificially prepared by the larva. The valuable silken cocoons of the larva of the *Bombus mori*, called, *par excellence*, the "silkworm," are familiar examples of pupal chambers. In this cocoon (showing No. 3073) of a larger lepidopterous insect, (*Oiketicus Kirbyi*,) the larva, by one of those marvellous prescient instincts which give so much interest to entomological inquiries, covers the close and thick web of fine and soft silk which it has prepared for its pupal repose, with a stronger outer defence of portions of twigs irregularly bound together by silken filaments; thus suspended to a branch of the tree, it deceives and escapes the attacks of predatory insectivorous birds. The pupæ whose cocoon remains partially open, as in *Saturnia* and *Phryganea*, are usually called "guarded," (*pupæ custodiatæ*.)

All pupæ which are placed in dark situations are colourless, or of a yellowish white, and become darker when exposed to the light. The pupæ of most butterflies, which are suspended in open day, are of a green or yellowish brown colour; some are speckled with glittering spots of golden hue, either natural, or produced by the attacks of parasitic insects; and such pupæ have obtained the name of "chrysalis" and "aurelia."

The active pupæ of Orthoptera and Hemiptera are called "nymphs." These insects, which are also said to have semi-complete pupæ, and to undergo an imperfect metamorphosis, are subjected, as I trust I have already proved, to the same law of repetition or analogy which is expressed so conspicu-

ously in insects to which alone a perfect metamorphosis has usually been attributed; for, although moulting be no metamorphoses, even when accompanied, as it usually is in insects, with a certain change in the form of the body, yet the course of the development of those insects which, after exclusion from the egg, are subject only to ecdysis and growth of wings during an active nymph-hood, manifests, prior to exclusion, the same analogies, which Oken expresses in the following words:—"Every fly creeps as a worm out of the egg; then, by changing into the pupa, it becomes a crab; and lastly, a perfect fly."

It is not, indeed, true that every flying insect creeps, as a worm, out of the egg; all the *Orthoptera* and *Hemiptera* are excluded under the type of the crab, *i. e.*, with perfectly developed jointed legs, eyes, antennæ, and maxillary organs. The metamorphoses which the locust undergoes in its progress from the potential germ to the actual winged and procreative imago are nevertheless as numerous and extreme as those of the butterfly. The differences are relative, not essential; they relate to the place in, and the time during which the metamorphoses occur, and to the powers associated with particular transitory forms of the insect. The legs of the worm-like embryo-locust were once unarticulated buds, like the prolegs of the caterpillar; but the creature was passive, and development is not superseded for a moment by mere growth; these organizing processes go on simultaneously, or rather, change of form is more conspicuous than increase of bulk; the six rudimental feet are put to no use, but constitute mere stages in the rapid formation of the normal segments, which attain their mature proportions and their armature of claws and spines, before the egg is left. The first segment of the originally apodal and acephalous larva is as rapidly and uninterruptedly metamorphosed into the mandibulate and antennate head, with large compound eyes.

Thus developed, the young Orthopteran or Hemipteran issues forth into active life. Instead of further individual improvement or development, it may at once begin the great business of its existence by parthenogenetic propagation of its kind, as in the *Aphis*, and feed and die without further change of form; but, generally, the active, crab-like larvæ are subject to three moults. After the first the larva has merely increased in size; but the rudiments of the wings begin to bud forth beneath the second skin; and, after the second ecdysis, they present themselves externally as small leaves, which cover the sides of the first abdominal segment. When this active pupa or nymph again moults, the insect attains its perfect condition; the, at first, short, soft, and thick wings rapidly expand to their full size, then dry in the air; the circulation of the blood along the nervures is arrested, and the metamorphosis of the individual is complete. Here, then, we see that the pupa stage, which, in the butterfly, was passive and embryonic, in the locust is active and voracious; whilst their respective conditions in the larval state are reversed. The whole period of the life of the Orthopterous insect, from exclusion to flight, may, if its organization during that period be contrasted with that of the Lepidopterous or Coleopterous insects, be called an active nymph-hood.

Entomologists, overlooking that stage of the Orthopterous and Hemipterous insects, in which they are masked by the vermiform or true larval condition, have arbitrarily applied the term "larva" to the more advanced stage in which these insects, with certain Neuroptera, quit the egg. Mr. Westwood seeing that at this stage they are nearly similar in form to the perfect insect, though wingless, has proposed to call them "homomorphous," or "monomorphous;" and those insects in which the larva is generally worm-like, &c., heteromorphous. It needs only an acquaintance with the embryonic changes of a cockroach or cricket to feel how inapplicable is the term monomorphous or uniform to such an insect or its development.

The chief business of an insect, for good or for evil, is performed in its larval state. The moth, which destroys your clothes, does it not in its complete, but its larval, stage. The cockchafer, which makes the young wheat-blade wither and fall, is a mere grub. Metropolitan duties shut out much of the field of nature; but still she may be found and studied everywhere. I first learned to appreciate the true nature and relations of the nominally various and distinct metamorphoses of insects, by watching and pondering over the development of a cockroach, which quits the egg as a crustacean. I saw that it passed through stages that answered to those at which other insects were arrested: there was a period when its jointed legs were simple, short, unarticulated buds, —when its thirteen segments were distinct and equal,—when it was apodal,—when it was acephalous.

Now, the differences of the larvæ which are distinguished by the entomological terms, Heteromorphous, Homomorphous, Capitate, &c., essentially depend upon their quitting the egg to enter into active life at different periods of development, arrested at different grades. And it is most interesting to observe, that these several grades are analogous to, or are typified by, the complete forms of the different recognised classes of the great articulate sub-kingdom.

And these phenomena of the development are most important to zoological classifiers. They establish satisfactorily our ideas of the natural character of a true natural group, as also the natural progression of the affinities of its several grades.

When we see the entozoiform acephalous type first assumed by the first transformations of the germ-mass, we feel an assurance nothing else could give, that we are in accordance with Nature in commencing the ascending series of articulate animals, which are to culminate in the winged insect, from the entozoa.

When we find that the annulose worm, with a modified segment for a head, and tubular feet, is the next form assumed, according to the type of the annellides, we are thereby confirmed in our departure, in this instance, from the authority of the great Cuvier, who, through assigning undue value to a single character, the colour of the blood, placed the annellides at the head, instead of near the foot, of the articulate series.

When the next step is seen to be the acquisition of articulate limbs, and jointed antennæ, we conclude, that the articulated animals arrested at this grade of outward form, ought to be the next in position in the series, notwithstanding that, in the *Crustacea*, as the class is called, certain higher members manifest a high and concentrated character of heart, as the annellides showed a high character in the red colour of the blood.

Other larvæ, by the successive development of simple feet (prolegs) upon numerous segments, with aggregated acelli on the head, typify the myriapodous order, and then pass on to the simultaneous acquisition of jointed legs and wings, and thus indicate the close and essential affinity of the myriapods to the hexapod insects. Thus do insects in their metamorphoses diversely typify a Divine archetypal pattern.

In the Coleoptera and Lepidoptera the general articulate type is longer retained, and the particular one later acquired. In the Hemiptera and Orthoptera the morphological and histological changes more rapidly and uninterruptedly effect the ascent from the common to the special form. Professor Burmeister, in his richly-stored Manual of Entomology, translated by Mr. Schuckard, states that, "In insects with an imperfect metamorphosis there cannot consequently be a passage through the earlier forms and grades of the animal kingdom" (Shuckard's Translation, p. 423). The consequence here referred to appears to be, as far as I can understand the Author, a hypothetical necessity in Nature, for a difference among insects with respect to their metamorphosis; but no insect, however metamorphosed, passes through the forms and grades of the radiate sub-kingdom. Commencing as a Hydatid, it quits that sub-kingdom by the analogy of the Entozoa, and its subsequent grades are through the forms of the Articulata exclusively. No insect ever is, or resembles the ciliated Infusory, the Polype, or the Acalephe. The insects with a so-called imperfect metamorphosis, contrary to the statement of Burmeister, do pass through the earlier forms of the articulate sub-kingdom, but more rapidly and uninterruptedly than those in which the metamorphosis has been deemed more complete. In these the worm-like insect or larva is active, and the crab-like insect or pupa passive; in those the larva is passive, and the pupa active.

If the different stages in the development of man were not hidden in the dark recesses of the womb, but were manifested, as in insects, by premature birth and the enjoyment of active life, with a limitation of the developmental force to mere growth; if the progress of development was thus interrupted and completed at brief and remote periods, with great rapidity, and during a partial suspension of active life;—his metamorphoses would be scarcely less striking and extreme, as they are not less real than those of the butterfly.

As the insect must pass through the earlier forms of the Articulate, so must man through those of the Vertebrate, sub-kingdom. The human embryo is first apodal and vermiform: not, however, at any period an articulated worm. The metamorphoses of the germ-cells in the spherical (hydatid-like) ovum have laid down the foundation of the nervous system coeval with the first assumption of a definite animal form; and, by placing it along the back as a rudimental spinal chord, supported by a gelatinous noto-chord, have stamped the vermiform human embryo with the characters of the apodal fish. When the four undivided compressed extremities bud out, the form of the abdominal-finned fish, or of the Enaliosaur, is indicated. The development of the heart, of the vascular arches, of the generative organs with their cloacal communication with the rectum, typify the oviparous reptile. But these stages are rapidly passed, and the special character acquired.

Let us suppose that man, or any mammiferous animal, quitted the ovum and the parent in the guise of the fish, passed a certain period in water, retaining the branchial structure, the undivided extremities and the cloaca, and acquired only increase of bulk under that guise; let us suppose that then such larva, seeking some safe hiding-place, returned to embryonic passivity and unconsciousness, and was rapidly transformed into the perfect state. Under this hypothetical modification of the course of human development, the changes of form would be plainly recognisable, and in the accessory circumstances, as well as the essentials, the mammalian metamorphoses would resemble those of the insect.

If, on the other hand, every insect had been developed like the *Diptera pupipara*, and the changes from egg to larva and from larva to pupa had been hidden in the oviduct of the mother, a long period might have elapsed before the recognition of these metamorphoses, and they could only at length have been discovered by a series of embryotomies, like those that have brought to light the corresponding metamorphoses of man and the mammalia generally.

By a premature exclusion and activity of the embryo, and by alternate periods of growth and development, one small group of vertebrate animals, the anourous Batrachia, do actually manifest the correspondence with the metamorphoses of insects, which I have illustrated by an instance of hypothetical possibility in man. Nay, do not the Marsupial mammalia offer an example of the premature exclusion? It needed only that the young kangaroo, with its equal and rudimental limbs, should possess, like the tadpole or caterpillar, the power of self-subsistence, and have gone on feeding and growing, whilst the further and final changes of form were reserved for, and concentrated in, a future brief period, to render the parallel almost complete. The creeping or swimming larva of the Mammal would then have gained its instruments for leaping, as the caterpillar acquires its organs of flight and the concomitant development and metamorphoses of the organs of sense, of digestion, and of generation, would have been closely analogous in both animals.

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RENDICONTI DELLA R. ACCADEMIA DEI LINCEI

Classe di scienze fisiche, matematiche e naturali

Estratto dal vol. II, 1° Semestre. fasc. 1° — Seduta dell'8 gennaio 1893.

G. CAPELLINI

COMMEMORAZIONE

DEL SOCIO

SIR RICCARDO OWEN

ROMA

TIPOGRAFIA DELLA R. ACCADEMIA DEI LINCEI

PROPRIETÀ DEL CAV. V. SALVIUCCI

1893

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Il Socio Capellini legge la seguente Commemorazione del Socio Owen.

« Il 19 decembre 1892, a Sheen Lodge nel Parco di Richmond, spegnevasi il nestore dei nostri colleghi stranieri, il valentissimo anatomico, il sommo paleontologo, Sir Riccardo Owen.

« Nato a Lancaster il 20 giugno del 1804, intraprese gli studi di Medicina nella celebre università di Edimburgo e a ventidue anni si addottorò nel Collegio dei Chirurghi in Londra, ove fissò la sua dimora per esercitarvi la Chirurgia. In quello stesso anno, essendo dissettore presso il celebre professore Abernethy, che primo ne apprezzò il talento per la Anatomia, esordì con un lavoro sui calcoli della vessica. Frattanto il Governo aveva acquistato pel Collegio dei Chirurghi le collezioni di Giovanni Hunter e allorchè nel 1828 si pensò di catalogarle e di utilizzarle con letture che ne facessero apprezzare la grande importanza, Abernethy designò il suo allievo R. Owen come la persona più adatta a disimpegnare quell'ufficio, spendendovi le ore di libertà.

« Conservatore del Museo del Collegio dei Chirurghi, in *Lincoln's-Ennfields* era allora Guglielmo Clift e anche dall'Owen si sapeva che avrebbe avuto per successore il figlio; ma allorchè questi per grave disgrazia morì improvvisamente e all'Owen fu riservato il mesto ufficio di annunciare alla famiglia amica la grande sventura, il vecchio Clift si fece promettere che avrebbe occupato il posto del figlio e che più non si sarebbe allontanato dal museo.

« Nel 1830 venne in luce la prima parte del Catalogo del Museo Hunteriano; in quello stesso anno alla Società zoologica di Londra R. Owen lesse il suo bel lavoro sulla Anatomia dell'*Ourang-Outang* e dal 1830 al 1832, con una trentina di altre pubblicazioni, si rivelò grande anatomico e distinto zoologo. Di quelle pubblicazioni merita di essere ricordata la bellissima Monografia nel *Nautilus pompilius* con stupendi disegni che attestano della valentia dell'Owen anche come artista; e poichè la parola artista mi è caduta dalla penna, accennerò che l'illustre scienziato fu anche distinto musicista, ciò che forse contribuì alla simpatia che ebbe sempre per l'Italia e per gli Italiani.

« Nel 1831 andò a Parigi per render visita a Giorgio Cuvier che aveva conosciuto a Londra, ove l'autore dell'opera immortale sulle *Ossa fossili* si era recato dopo la abdicazione di Carlo X. Pare che dalla visita al Museo del Giardino delle Piante e ai laboratorî di Cuvier e Valenciennes Owen tornasse a Londra profondamente impressionato, sentendosi attratto egli pure in modo particolare allo studio dei Vertebrati fossili.

« Aveva appena trent'anni allorchè scoprì la *Trichina spiralis* e fu eletto membro della Società Reale di Londra, della quale in seguito fu degnissimo Presidente.

« Nel 1835 fu chiamato a succedere a Carlo Bell nell'insegnamento della Fisiologia e della Anatomia comparata.

« Nel 1836 divenne genero di Clift e, dopo la morte del suocero ebbe anche la direzione del Museo del Collegio dei Chirurghi, continuando ad occuparsi del Catalogo al quale lavorò per circa trent'anni. Il Catalogo dei Mammiferi e Uccelli fossili fu pubblicato nel 1845 e in esso si trovano importantissime notizie sui *Dinornis* della Nuova Zelanda, sul *Mylodon robustus*, sul *Glyptodon claviceps*, sul *Nototherium* e sul *Diprotodon*.

« E mentre R. Owen, senza trascurare le lezioni disimpegnava con zelo e alacrità le gravi cure del museo Hunteriano, preparava il colossale classico lavoro sui denti dei Vertebrati (con 150 stupende tavole) del quale il celebre anatomico bolognese Antonio Alessandrini pubblicava pel primo un sunto prezioso e assai esteso in Bologna nei « Nuovi Annali delle Scienze naturali » (1).

« Ma quasi che tutto ciò non bastasse, accettava l'incarico di un corso di Paleontologia nella R. Scuola delle Miniere; e tra i primi ad apprezzare il vantaggio che l'Anatomia poteva ricavare dalla applicazione del microscopio nello studio dei tessuti, contribuiva efficacemente alla fondazione della Società microscopica di Londra.

« Sua Maestà la Regina Vittoria e il dotto Principe Alberto apprezzando la vasta dottrina e le belle qualità d'animo del prof. Owen, gli affidarono l'onorevole incarico di un corso di Storia naturale per il Principe ereditario; ma per la soverchia fatica, per tante lezioni, la sua salute finalmente ne ebbe a soffrire e nel 1856 rinunziando al Collegio dei Chirurghi fu nominato Presidente del Dipartimento di Storia naturale del Museo britannico di Londra. Succedendo al dott. E. Gray nell'alto ufficio e abbandonata la cattedra consacrò tutta la sua attività all'incremento della scienza e al maggiore sviluppo di quel grande Istituto, il primo per non dire l'unico nel suo genere.

« Dal modesto gabinetto del grande paleontologo escirono ogni anno numerose importantissime pubblicazioni, e arduo sarebbe di volerle, non dirò tutte ricordare, ma anche solo di accennarne le più rimarchevoli; le ultime a me note sono del 1887 e complessivamente raggiungono la cospicua cifra di oltre quattrocento.

« Meritano speciale attenzione, e non posso passarle in silenzio, le classiche monografie sui Rettili fossili del Cretaceo e del Lias d'Inghilterra pubblicate nei volumi della Società paleontografica di Londra, 1865-1877; quelle sui Rettili fossili dell'Africa, 1876; la paleontologia del *Megatherium*; la descrizione dello scheletro del *Mylodon robustus;* la illustrazione dei resti di mammiferi fossili raccolti da Darwin nella circostanza del viaggio dello *Beagle*, fra i quali gli avanzi del nuovo genere *Scelidotherium*.

« Il lavoro sull'Archetipo e le omologie dello scheletro dei vertebrati, quelli sull'Aye-Aye (*Chyromis*), sul Gorilla, sul Dodo, sull'Apterige e special-

(1) Owen R., *Odontography or a Treatise on the Comparative Anatomy of the Teeth.* ec. *in the Vertebrate Animals.* London, 1840-45. — Nuovi Annali delle Scienze nat. Serie 2ª. t. I. Bologna 1844 e seg. fino al 1883.

mente sull'uovo e sul pulcino di quel singolare uccello, sui *Dinornis* della Nuova Zelanda e sui giganteschi marsupiali fossili di Australia, sull'*Odontopteryx toliapicus* (uccello con denti), sull'anatomia del *Limulus polyphemus* e sull'*Archeopteryx lithographica*, basterebbero ad attestare la vastità della dottrina del primo Anatomico del Regno Unito che meritò di esser detto il Newton della Storia naturale.

« Sua Maestà la Regina Vittoria fino dal 1852 volendo offrire all'Owen il modo di curare la sua preziosa salute e di doversi necessariamente riposare, almeno per alcune ore, lontano dal Museo cui aveva consacrato la sua vita, gli concesse di abitare una graziosa villetta (Sheen Lodge) con laghetto e giardino, nel R. Parco di Richmond, e fino dalla mia prima visita a Londra, nel 1859, e in molte altre circostanze fino al 1887, sulle rive di quel laghetto ove gli agili daini venivano a specchiarsi, ebbi con l'amico dilettissimo le più interessanti conversazioni e ripetute prove della impareggiabile bontà sua per gli studiosi e della sua grande simpatia per il nostro paese.

« E a questo proposito mi sia permesso di qui ricordare che, con lettera affettuosissima del 24 settembre 1870, ossia il quarto giorno dell'entrata delle truppe italiane in Roma, R. Owen si congratulava per il felice compimento dei nostri voti, chiamando l'Italia « *Noble and intellectual Nation* ».

« Recandosi in Egitto per motivi di salute, più volte ebbe occasione di trattenersi in Bologna per ammirare i preziosi resti di vertebrati fossili dell'Istituto geologico e fu allora lietissimo di conoscere di persona il Calori, l'Ercolani e altri illustri colleghi di quell'antichissima Accademia delle Scienze, alla quale era ascritto fino dal 20 giugno 1847. Per la prima volta potè vedere in Bologna uno scheletro intero di *Scelidotherium*, genere di Megateride da lui fondato coi resti incompleti raccolti da Carlo Darwin nel 1833 a *Punta Alta* nel nord della Patagonia, e ne apprezzò non solo la importanza scientifica ma eziandio il valore commerciale, offrendo egregia somma se avessi voluto cedere pel Museo britannico quel raro fossile di mia assoluta proprietà e allora già quasi completamente restaurato.

« Del Sirenoide pliocenico, pel quale creai il nuovo genere *Felsinotherium* particolarmente si interessò, e nel suo lavoro sul *Prorastomus sirenoides* della Giammaica, dopo accurati confronti col fossile bolognese, riconosce giuste e accetta interamente le mie considerazioni sui rapporti dei Sirenoidi viventi e fossili (1).

« Anche in una Nota intorno a resti di un Sirenio (*Eotherium aegyptiacum*) nel calcare nummulitico di Mokattam parla del *Felsinotherium* (2) e per

(1) Owen R., *On Prorastomus sirenoides*, Ow. Part. II. Quarterly Journal of the Geological Society. Vol. XXX, p. 559. London, 1875.

(2) Owen R., *On Fossil evidence of a Sirenian Mammal* (*Eotherium aegyptiacum*, Ow.), *from the Nummulitic Eocene of the Mokattam Cliffs near Cairo*. Quart. Jour. of the Geol. Soc. Vol. XXXI, p. 100. London, 1875.

tutte le scoperte e per gli studi sui Cetacei e sui Rettili fossili, egli valentissimo in quella materia si espresse sempre con modi molto lusinghieri e con parole di incoraggiamento.

« Dopo una lotta di molti anni, nel 1872 avendo vinto tutte le difficoltà per la costruzione del nuovo Museo nazionale di Storia naturale a Kensington, lontano dal centro affumicato di Londra, con febbrile attività si occupò del trasporto delle preziose collezioni nel colossale sontuoso edifizio di *Cromwell Road* che occupa una superficie di quasi 7500 metri quadrati e non aspirò più ad altro che a veder compita un'opera per la quale si era tanto affaticato. Il Museo fu aperto al pubblico per la prima volta il lunedì di Pasqua del 1881 e in quel giorno vi furono circa 16,000 visitatori; però la sistemazione delle collezioni durò ancora assai tempo. In una lettera del 2 decembre 1883 Owen mi informava di aver ricevuto un telegramma di Sella col lieto annunzio della sua nomina a Membro della nostra Accademia (*Member of the ancient and honorable* Accademia R. dei Lincei) e mi esprimeva la sua contentezza di aver quasi compito la sistemazione delle collezioni di Zoologia, Paleontologia, Geologia, Botanica e Mineralogia nei nuovi e splendidi locali, aggiungendo che quel lavoro lo aveva piacevolmente occupato negli ultimi due anni (1).

« Il 31 di quello stesso mese R. Owen aveva mandato le sue dimissioni dall'ufficio di Direttore del Museo britannico di Storia naturale e la tessera di Linceo (*The valued Diploma in a Tabula aenea*), giunta poco dopo al suo indirizzo, *Cromwell Road*, ivi restò lungamente dimenticata e l'ebbe soltanto verso la fine del maggio 1884; del che lamentandosi, temendo di essere apparso scortese verso la famosa R. Accademia dei Lincei e il suo venerato Presidente, mi incaricava di informarne i Colleghi e di rinnovare le sue scuse.

« Fui a salutare il venerato maestro a Sheen Lodge il 27 agosto 1887; egli presentiva che quella era l'ultima nostra intervista; mi volle trattenere fino a tarda sera; mi donò le sue ultime pubblicazioni ed una delle ultime rose del suo giardino.

« Nel giugno 1888 l' *Alma Mater Studiorum* commemorando l'ottavo suo Centenario, su proposta delle Facoltà di Scienze fisiche, matematiche e naturali, acclamava Dottore *Honoris caussa* Sir R. Owen e l'illustre vegliardo nobilmente fiero per sì alta onorificenza ringraziava con bellissima lettera latina del 26 luglio, tutta di suo pugno, aggiungendo particolari congratulazioni ed augurî per l'antico amico Rettore che immaginava al colmo della gioia e degli onori, avendo dimenticato che non vi ha rosa senza spine.

« Un uomo così grande e così buono come fu Sir Riccardo Owen avrebbe dovuto essere bene amato da tutti; ma forse tardi s'accorse che vivendo lungamente, se non altro, si disturbano le impazienti aspirazioni.

(1) Sua Maestà la regina gli aveva conferito la Commenda dell'Ordine del Bagno, col titolo di *Sir*.

« La freddezza degli avversarî ha impedito che le ceneri del grande Naturalista siano accolte nell'Abbazia di Wesminster per essere deposte presso quelle dei più illustri figli di Albione; il tempo farà giustizia!

« Ai funerali, il Granduca di Teck rappresentava la Famiglia Reale e Delegati di tutte le Società scientifiche di Inghilterra e di molte straniere accompagnarono la venerata salma da Sheen Lodge alla chiesa di Ham; ivi riposerà presso chi ebbe in vita lungamente sua diletta compagna.

« Una statua in marmo sarà innalzata a Sir R. Owen nel Museo di Storia naturale da lui creato ».

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REVIEWS.

I.—The Life of Richard Owen.[1] By his Grandson, the Rev. Richard Owen, M.A. With the Scientific portions revised by C. Davies Sherborn. Also an Essay on Owen's Position in Anatomical Science by the Right Hon. T. H. Huxley, F.R.S. 2 vols. 8vo. Pp. 409 and 393, with Portraits and Illustrations. (London: John Murray.)

[1] For an Obituary of Owen, accompanied by an excellent portrait, see Geological Magazine, 1893, Decade III. Vol. X. p. 49.

THE record of the life of so well known a man as the late Prof. Owen cannot fail to be of great interest, not only to those to whom his researches more especially appeal, or who have known him as a friend, but also to the more general reader. For Owen, although a scientific man whose province was principally that of Comparative Anatomy, and perhaps more especially that of Vertebrate Palæontology, was at the same time a man of very broad human sympathies, and devoted a large amount of his earlier life to the services of his fellow-men by acting on various hygienic commissions; he was further very successful both as a popular and a special lecturer; finally, his efforts as Hunterian Professor at the Royal College of Surgeons, and afterwards as the first Director of the Natural History Department of the British Museum, did more than any of his predecessors to bring the study of Natural History before the public, to force its recognition on, and obtain its continual support from, the Government. It is hardly an exaggeration to say that Owen was the most popular and widely known of all the scientific men the present century has seen. These records consist of letters and extracts from the diaries of Prof. Owen and his wife, more especially from that of the latter, who, it appears, kept a most exhaustive account of all Owen's doings and work. It is delightful to notice what deep interest she took in all his researches, and how carefully she recorded their progress; and the fact that she did not complain even when the house was occupied by a defunct Rhinoceros or portion of an Elephant sufficiently hung to necessitate keeping all the windows open, shows that she was a most sympathetic wife for a scientific man.

Vol. I. commences with Owen's ancestry, and his early training at school and at home; his letters to and from his mother and sisters show what a lovable man he was. It is amusing to read of his having been stigmatized while at school as "lazy and impudent": what would that master think of his forecast if he could read these volumes? We find an interesting account of his early taste for ethnology in his adventure with the negro's head (page 23) during his apprenticeship to a surgeon at Lancaster. But it was not until he went to Edinburgh, where he founded the Hunterian Society, that his scientific inclinations were really manifested. From Edinburgh, acting on the advice of Barclay, he came to London to study at St. Bartholomew's under Abernethy, and it was owing to the recommendation of the latter that he was appointed Assistant Curator of the Hunterian Collection at the Royal College of Surgeons.

It is from this date (1826) that Owen's career as a scientific man commenced, and the greater part of Vol. I. is devoted to his life at the College of Surgeons. This is, perhaps, the most interesting part of the work, for we are able to trace how he gradually weaned himself from medicine and devoted himself more and more to comparative anatomy, due in the first place to the nature of his work, and also, probably, in a large manner to the unconscious influence of the great scientist with whom he came in contact. One of the earliest of these was Cuvier, who visited the College and invited Owen to return to Paris. His biographers evidently consider that the supposed influence of Cuvier on Owen's future work has been overestimated, but, as Huxley points out, Cuvier's works stood out so pre-eminent amongst those of the comparative anatomists of those days that they must have had considerable influence in directing the method of work of a young aspiring anatomist such as Owen then was, and the mere fact of no reference of such influence being recorded in Owen's diary goes for nothing.

It is perfectly marvellous to note the amount of energy which Owen must have possessed, for we read of his working all day at his catalogues, his dissections, his lectures, and his duties on various Commissions, then winding up the day with theatres or concerts, and commencing the next by sitting up to write scientific papers or, sad to relate, to consume novels.

During the thirty years of his connection with the College of Surgeons, the most important of Owen's scientific work was done; and we are here able to read of the rapid growth of his now world-wide reputation as an Anatomist and a Palæontologist. Here, too, we read of his social intercourse with all the leading celebrated men of those days. To the general reader this portion will especially appeal, for here we find interesting letters and anecdotes of Turner, Carlyle, Dickens, and many more distinguished men in every branch of life.

In the second volume we come to Owen's connection with the British Museum, and a special chapter is devoted to the account of his efforts and ultimate triumph in the removal of the Natural History Collections to a special building. In the second volume are reproduced Owen's original plan and Waterhouse's first modification of the same; in both of these we recognise a building intended to serve primarily as a Museum provided with lecture theatre and teaching collections. How the present architectural structure, devoid of so many of the best features of the original design arose, is not explained.

Appended to the second volume is an interesting account tracing the development of Anatomical Science, and Owen's relation to the same, by Prof. Huxley. This is written in such a manner that it may be easily followed by the non-scientific reader. It seems a pity, for the sake of the latter, that this was not rather placed as an introduction to Vol. I.

The perusal of this work by the public would do much to dispel the favourite representations of scientific professors being necessarily dry old bones, for Owen was one of the most charming of men, and, in addition to his great qualifications as a scientist, was pre-eminently calculated to shine in society. The recognition of his social qualities may be seen all through his life, both by Royalties and Commoners; and we find him being entertained by the Prince of Wales, and by his fellow scientists, at social meetings where every kind of "ology" was barred.

The two volumes contain some charming portraits of Owen, especially the frontispiece to the second volume; there are also illustrations of Owen's most important discoveries. As an Appendix we find a most imposing list of his distinctions, and a complete list of all his works, numbering in all about 650.

— H. F. Woodward.
Geol. Mag. 1895.

HUNTERIAN LECTURES

ON THE

GENERATION AND DEVELOPMENT OF THE INVERTEBRATED ANIMALS.

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[*Reported expressly for the "Medical Times," and revised by the Lecturer.*]

LECTURE XVIII.

GENERATION OF ARACHNIDA.—Characters of the class, and of its chief divisions.—Androgynous condition of the Tardigrada: conversion of moulted integument into an ovicapsule.—Testes and penis of Mites.—Male organs of Spiders: termination of sperm-ducts remotely from the vesiculæ seminales: transfer of these sacs and the intromittent organ to the end of the cephalic palpi.—Tubular testes of Scorpions and their anastomoses: short sperm-duct and long cœcal sperm-sacs: papilliform penis: Pectinate appendages.—Ovaria and oviducts of Mites and Phalangiæ.—Long ovaria and short oviducts of Spiders: spermatheca and modifications of vulva.—Female organs of Scorpions: developmental pouches of the viviparous species.—Coitus and oviposition of Spiders: their strong maternal instincts: silken and other nests.—Development of germ and embryo: early manifestation of the class-character.—Repeated ecdysis during growth.—Regeneration of parts of Spiders.—Organs for secreting the material of the nests and webs.

MR. PRESIDENT AND GENTLEMEN,—There still remains one class of the great sub-kingdom of articulated animals, in which we have to examine the organs of generation, and consider the modifications of the functions by which the race is perpetuated. This class is called "Arachnida;" it includes the spiders and other air-breathing *Articulata*, which, like them, are without wings, without antennæ, but have four pairs of legs. As I have reserved this class to the last in the present progressive and ascensive survey of the generative function, you will conclude, that the species composing it are the highest of the Articulate series, notwithstanding they are devoid of those instruments of flight, which were so excellently and variously organized in the preceding class. Many Arachnidans are, in fact, parasitic; a few are aquatic; but the majority are terrestrial. Some, nevertheless, though devoid of wings, can float in the higher regions of the air; but they traverse that element as aëronauts, buoyed aloft on long silken filaments which they fabricate, lighter than air. Some of my hearers have doubtless witnessed this phenomenon during the warm, dry, sunny days, at the latter end of summer.

The Arachnida, like insects, are organised to live in and breathe air; but they are distinguished at first sight by the general form of the body and the number of their legs, and by some important modifications of their internal structure. The head is always, in the Arachnida, confounded with the thorax, and is deprived of antennæ, or at least of homologous parts exclusively employed in sensation. They have four pairs of legs. Some of the species respire by pulmonary sacs only; in others, these are associated with ramified tracheæ, and the smaller Arachnidans breathe, like insects, by tracheæ exclusively. The dorsal vessel and a circulating system exist in all; the heart presents a more compact and muscular form in the pulmonary Arachnidans.

The integument is chitinous, as in insects, but presents the same variations in density, in different species, as in the winged Articulata. In the scorpions, it is as dense and inextensible as in the Coleoptera: in the spiders and mites it is generally softer than in insects, especially that of the abdomen.

The body is divided into two principal parts, of which the anterior is called the "cephalothorax," because it answers to the two first segments of insects in a confluent state; the second and larger division is called the "abdomen;" it is generally larger and wider than the first, from which it is divided by a deep constriction; but in scorpions it forms, as in Crustaceans, a slender continuation of the thorax, a kind of caudal appendage divided into many joints. The organs of locomotion are all attached to the cephalothorax, and consist of eight legs, presenting different grades of development in the different forms of the class, but, in most, being very similar to those of insects, and almost always terminated by two hooks.

We are led by a close series of gradations in the present class to species presenting a higher and more concentrated type of the heart and the respiratory system than any of the true insects attain to; but, perhaps, the more decisive mark of the superiority of the Arachnida is recognised in the study of their development. They not merely do not undergo metamorphoses in the sense in which the term is usually understood in insects, viz., by the exercise of active life during an early stage of development; but they do not pass through the same series of inferior articulate forms in the course of their uninterrupted development. The Arachnida are amongst the few animals of their grade of organization that are built up at once according to their family pattern. Before even the germ-mass has been covered by the colliquamentum or embryonal skin, the characteristic cephalothorax and abdomen have been sketched out. The Arachnida must not, however, be supposed to stand, as a whole, superior to the insecta; organization does not march in and by them directly from the winged Articulata; they are rather a collateral or diverging branch, which springs from a very low point; so low a one, that some have mistaken these protarachnidans for entozoa.

The microscopic parasite of the sebaceous sacs and hair-follicles of the human skin, discovered by Dr. Simon, of Berlin, and described in "Müller's Archiv. fur Physiologie*," represents the lowest organised form of the class Arachnida, and, like the parasitic Cymothoe and Bopyrus of the Crustaceous class, makes a transition from the Anellides to the higher articulata. In length it ranges from 1-50th to 1-100th of an inch. In this microscope you will see after the lecture, a magnified view of the human hair-follicle, containing the bulb of the hair, the appended sebaceous sac, and the duct containing the parasitic Arachnidan in question. That this parasite ranks with the Arachnida, and not with the red-blooded or any of the lower organised worms, is evident from the division of the body into thorax and abdomen, from the structure of the head and mouth, which are confluent with the thorax, and from the undivided abdomen. The thoracic appendages, eight in number, as in the Arachnida, are, however, of the simplest and most rudimental kind, and are terminated by three short setæ; the Anellidous type of the locomotive appendages being still retained. The integument of the abdomen is very minutely annulated. The mouth is a suctorial one, or proboscidiform, consisting of two small spine-shaped maxillæ, and an extensile labium, capable of being elongated and retracted; it is provided on each side with a short and thick maxillary palp, consisting of two joints, and with a narrow triangular labrum above. Although the structure of the mouth, as described and figured by Dr. Simon, has much analogy with that of the *Acari*, like which, also, the follicular parasite in one of its stages of development is a hexapod, yet it differs from the *Acari*, and from all other *Holeteræ* of Dugés, in the articulations of the thorax; whilst it equally differs from the *Pseudo-scorpionidæ*, and the *Pycnogonidæ*, which have the thorax articulated, in the rudimental form of the feet, and the structure of the trophi.

It can hardly be supposed, that the changes of form indicated by the figures 8, 1, and 2 of Dr. Simon's memoir can be acquired without ecdysis; but such a metamorphosis, with the natural divisions of the body, and the structure of the oral and thoracic appendages, indubitably raise the parasite of the hair-follicle above the Entozoa, to which class Prof. Erichson, in Dr. Simon's Memoir, has correctly stated that the present parasite cannot belong. For the reasons above given, I cannot assent to the place which that accomplished naturalist has assigned to the Arachnidan in question among the *Acaridæ*, much less to the genus *Acarus*. Of the generic distinction of the parasite there can be no doubt, and I have therefore proposed to call it *Demodex folliculorum*, from δημος, lard, and δηξ, the name of a boring worm, indicative of the habitat and vermiform figure of this parasitic arachnidan, which insinuates itself into the hair-follicles and the sebaceous glands that communicate therewith.

In some of the small and parasitic tracheary Arachnida, or mites, certain pairs of legs are terminated by adhesive suckers, and others are occa-

* 1842, p. 218, pl. xi.

sionally terminated by setæ, as in the itch-mit. (*Sarcoptes Galei.*)

The mouth, in all Arachnidans, is situated on the anterior segment, and is provided with instruments adapted either for suction or mastication. In the parasitic mites the rudiments of the jaws are more or less enveloped in a sheath formed by the lower lip: the maxillary palpi are usually the only parts which have free and independent movements, and their extremity is commonly armed either with a hook or with a pair of small nippers.

In spiders the mandibles are situated at the front of the head, and are terminated by a moveable and very sharp hook, which is pierced at its extremity by a small fissure, serving to give issue to the poison secreted by a gland lodged in the preceding joint. The maxillæ are two in number, and the labium situated between these organs is composed of a single piece. The maxillary palpi, compared with those of insects, are of great length and size, and resemble the thoracic feet, which, in the Mygale, they nearly equal in length. In female spiders they are terminated by a single moveable claw: in the males the last joint is dilated, and presents a more complicated structure. In the scorpion the mandibles are short and terminate in a pair of strong pincers; the maxillary palpi are proportionally more developed than in the spiders, and, like the mandibles, they terminate by pincers, which, are so strong and large in the great scorpion (*Buthus Africanus*), as to resemble the chelæ of the Crustacea, and more especially as they are succeeded by four pairs of simple and smaller thoracic legs.

In the genus *Galeodes* the mandibles are chelate, but much longer and larger than in the scorpions. The maxillary palpi resemble small slender feet, but without the terminal hooks; and the succeeding pair of legs being similarly modified, only six ambulatory feet of the ordinary structure remain. Two rudiments of antennæ have been noticed attached to the mandibles in certain species of this genus. The head is likewise more distinct from the thorax, and it supports the first of the four pairs of legs usually ascribed to the Arachnida. These modifications, with the union of the ocelli into two groupes, indicate the Galeodes to form the passage to the Hexapod insects.

The modified form of the pair of legs which succeeds the maxillary palpi in the *Galeodes*, indicate their homology with the labial palpi in insects, and their connexions demonstrate them to be those organs, although modified for a different function in the present class. The connexions, also, of what are called "mandibles" in spiders, and "chelæ" in scorpions, and especially the origin of the nerves of those parts from the brain or supra-œsophageal ganglian demonstrate them to be modified antennæ, which are analogous, in the spider, to the poison-fangs of the rattlesnake or viper, and in the scorpions, to the pincers of the crab and lobster.

Before entering upon the description of the generative organs in the typical forms of the *Arachnida*, I am led to offer a few remarks on another low organised arachnidan, which, on account of its remarkable power of retaining life, and reviving after some years complete desiccation, has received the generic name of *Macrobiotus*. This minute and peculiarly shaped mite, in which the hinder rudimental legs come off from the abdomen, was discovered by Eichhorn in 1767, and was described by him under the name of "water-bear," (wasser-baer.) Corti, in 1774, recounted its power of returning to life after being dried. It is not uncommonly found in the gutters of the roofs of continental houses; it crawls along the sediment like a tortoise, and was grouped by Spalanzani with the Rotifers, under the name of "tardigrade." Otho Fred. Müller first detected its true relationship with the mites. It is subject to many moults and oviposits in its exuviæ.

The *Macrobiotus* is androgynous, and the only known arachnidan that is so. The testes are two long fusiform sacs, situated one on each side of the single ovarium and of the intestine; they communicate with a median dorsal vesicula seminalis, in which Doyère and Dujardin have detected actively moving spermatozoa. The ovarium is a large sac, with loose and dilatable tunics, situated dorsad of the intestine and advancing, when gravid with ova, as far forwards as the first segment of the trunk. A short oviduct opens at the fore part of the cloaca, which is on the ventral aspect of the penultimate segment. The ovarian sac is sustained by two suspensory ligaments or muscles, which diverge to be attached, above the gastric division of the alimentary canal, to the internal dorsal muscle of the second segment. The ova, which are usually five or six, rarely more than ten in number, are simultaneously developed, and of large proportional size. The clear germinal vesicle is imbedded in a coloured yolk, enclosed in a membrana vitelli. The chorion is smooth when oviposition and moulting go on together, and the cast skin receives the eggs; at other times the chorion is beset with points or tubercles. The germ-mass is transformed at once into the Macrobiotus; the young animal moves on the twentieth day, and is excluded on the twenty-fourth, unless it happens to become dried; when the young becomes torpid like the parent, and both revive when they are re-moistened. It is about one-fourth the size of the parent.

All the Arachnidans of the mite family are remarkable for their power of resisting lethal influences, and for the retention of their vitality when torpid and apparently dead. The ova of such are, with still greater difficulty, deprived of their latent life. As all the mites have been endowed with well-developed, if not complex, generative organs, the requisite proof must be satisfactorily afforded of the impossibility of the existence of the eggs of mites in, or of the access of such to, fluids traversed by galvanic currents, before credence can be reasonably given to the statements that acari can have been developed by such agency, without any pre-existing egg, *i. e.*, by way of the "*generatio spontanea seu equivoca.*"

In the genius *Trombidium*, the species are, as in other true mites, represented by distinct males and females; the testes form one compact mass, consisting of a groupe of red-coloured sperm-sacs, attached by a short stem to an annular vas deferens, which opens between the hindmost pair of legs, but receives before its termination the ducts of two vesiculæ seminales. In the female the ovarium is large and apparently single, but from it there proceed two oviducts. Mites are oviparous; and, a few days ago, Mr. Rainey was so obliging as to show me the eggs of the *Acarus* or *Sarcoptes Galei*, which he had discovered beneath the epithelium, in an itch patient at Guy's Hospital.

In the true spiders (*Araneidæ*) the males are characterised by their smaller size, their longer limbs, and brighter colours, as compared with the females; but more decisively by the turnid and unarmed termination of the long maxillary palpi; the parts analogous to "vesiculæ seminales" being lodged here. The essential and the accessory generative organs of this sex are quite distinct and remote from each other: the principle of such separation, which is exemplified in the relation of the Fallopian tube to the ovarium in Mammalia, is carried to an extreme in regard to the vesicula seminalis and testis in the spiders. If the analogy of the female parts be here, as in other animals, a guide in the determination of the essential organs of the male, the testes ought to be the two long vermicular tubes, applied to the under wall of the abdomen, which commence posteriorly, either by a simple sac, as in the Mygale, or by an oblong vesicle, as in the genius *Pholcus*, the ducts of both of which terminate anteriorly by two approximate orifices, or else by a common opening, situated between the two pulmonary stigmata. These abdominal testicular sacculi are, in fact, laden at the breeding season with sperm-cells and their characteristic nuclei or "spermatoa," from which the spermatozoa are afterwards developed.

The second or copulatory part of the generative organs is confined to the two last joints of the maxillary palp; the dilatation of these joints is chiefly formed by a spoon-shaped membranous tube or sac, commencing at the penultimate and reaching its greatest expansion at the last joint: this tube appears to line a cavity in the ordinary state; but it can be distended, everted, and erected, when it is seen to be terminated by a horny appendage. In this sac the spermatozoa are found both free, and in the interior of the sperm-cells, having escaped from the spermatoa into the cavity of the parent sperm-cell.

In the female spider the ovarium sometimes presents the form of a simple elongated fusiform vesicle, closed at one extremity and communicating with a slender oviduct at the other, which duct, after more or fewer convolutions, terminates at the corresponding angle of the simple transverse vulva. It is situated, like the outlets of the vasa deferentia, between the pulmonary stigmata. Each ovarium is divided in the Epeira, or diadem-spider, by a transverse septum, and the eggs are laid at two distinct periods. In the common house spider the ovisacs are developed, like grapes, from a central stem-like ligament, to which they are appended by slender peduncles, the whole being inclosed in the common capsule.

The most careful observations, repeated by the most attentive and experienced entomologists, have led to the conviction that the ova are fertilised by the alternate introduction into the vulva of the appendages of the two palpi of the male. Treviranus's supposition that these acts are merely preliminary stimuli, has received no confirmation, and is rejected by Dugés, Westwood, and Blackwall; and with good reason, as the detection of the spermatozoa in the palpal vesicles has shown. At the same time, the most minute and careful research has failed to detect any continuation of the vas deferens into the terminal erectile sac of the palp, or any other termination than the abdominal opening above described. Dugés offers the very probable suggestion that the male himself may apply the dilated cavities of the palpi to the abdominal aperture, and receive from the vasa deferentia the fertilising fluid, preparatory to the union; and the discovery of the spermatozoa at an earlier stage of development in the abdominal testes, which development is completed after the transference of the semen to the vesiculæ, equally demonstrates the respective shares which the two widely separated parts of the male apparatus perform in these remarkable articulata. The analogy of the separate location of the testes and vesiculæ seminales in the dragon-fly will no doubt present itself to the mind. Certain it is that an explanation of this singular condition of the male apparatus, in which the intromittent organ is transferred to the remote and outstretched palp, is afforded by the insatiable proneness to slay and devour in the females of these most predacious of articulated animals.

The young and inexperienced male, always the smallest and weakest of the sexes, has been known to fall a victim, and pay the forfeit of his life for his too incautious approaches. The more practised suitor advances with many precautions, carefully feels about with his long legs; his outstretched palpi being much agitated; he indicates his approach by vibrating the outer border of the web of the female, who answers the signal, and indicates acquiescence by raising her fore-feet from the web, when the male rapidly advances; his palpi are extended to their utmost, and a drop of clear liquid ejected from the tip of each clavate end, where it remains attached, the tips themselves immediately coming in contact with a transverse fleshy kind of teat or tubercle protruded by the female from the base of the under side of the abdomen. After consummation, the male is sometimes obliged to save himself by a precipitate retreat: for the ordinary savage instincts of the female, "etiam in amoribus sæva," are apt to return, and she has been known to sacrifice and devour her too long tarrying or dallying spouse.

There is a redeeming feature, however, in the psychical character of the female spider, in the devotion with which she fulfils all the duties of the mother. But before proceeding with the examples of the maternal instinct, I shall first point out the anatomical character of the generative organs in the scorpion.

The palpi of the scorpion take no share in the formation of the generative system in either sex; both male and female are provided with a pair of peculiar comb-like appendages, attached directly behind the genital aperture, which is situated at the middle line of the under and posterior part of the abdomen. Müller has observed, that the teeth in the comb of the male scorpion (*Buthus Africanus*)

are much more numerous and smaller than those in the female; but the sexes are not otherwise distinguishable outwardly. The males appear to be fewer in number than the females.

The testis of the scorpion is a long and slender tubulus, which divides, and the divisions anastomose together to form three loops or meshes. A short blind sac *(Vesicula glandularis)* communicates with the termination of the tubulus, and the common duct terminates in an oblong receptacle, the outlet of which is situated close to the corresponding one on the opposite side of the body, at the middle of the under part of the last segment of the thorax.

The tubular oviduct of the female scorpion divides and unites with its fellow through the medium of a third shorter middle canal, forming three meshes on each side, and a seventh longer anterior loop by the terminal union of the oviducts before they open upon the bivalvular vulva.

The ovaria consist of lateral appendages going off at right angles from the longitudinal canals, and expanding into elliptical sacculi before communicating with the canals; the ova are developed in the slender blind free extremities or beginnings of the ovaria, and the embryo is developed in the sacculus, the scorpion being viviparous. The course of its development, which would be a subject of great interest, has not yet been traced. In the separate outlets of the sperm-ducts in the male, and of the oviducts in the female, the higher *Arachnida* manifest an analogy with the Crustacea.

All spiders are oviparous. The mother prepares a soft and warm nest for the eggs, which she guards with great care. The *Lycosa vagabunda* carries her cocoon about with her; if it be removed and a ball of cotton substituted, she has been known to bestow upon it the same care; but when the cocoon was offered together with the cotton ball, she seldom failed to select her own fabrication. The *Saltica* selects an empty snail shell for her cocoon, and spins a silken operculum across the mouth. The *Epeira fasciata* encloses her eggs, which are as big as millet-seed, in a papyraceous cell, surrounded by a cottony covering, which she then suspends by a dozen threads or pillars to a larger chamber of silk. The whole is attached to a branch of a high tree, and is guarded by the mother, who quits it only in extreme danger, and returns when this is past.

Bonnet, finding in his garden the pit-fall of the larva of the ant-lion, took a spider with her cocoon, and threw them in; the spider crawled up the side of the pit, but before she could escape the ant-lion seized the cocoon and tore it from the female; she returned and seized it, and a battle of some minutes ensued. The ant-lion, however, succeeded in mastering the spider and retaining the cocoon. Bonnet then rescued the mother and placed her at the margin of the pit, but she refused to abandon her offspring, and remained there, passive, as if she had lost everything that was worth living for.

Prior to impregnation the ovum consists of a yolk and delicate yolk-membrane, containing a large germinal vesicle, whose nucleus shows several nucleoli, and, besides this, a peculiar firm corpuscle, discovered by Siebold and Von Wittich, usually consisting of fine concentric layers, more seldom granulated, and disappearing in the fully developed ova.

The ovum of the spider, at its exclusion, consists of a large and finely granular vitellus, invested by the membrana vitelli, which is separated from the chorion by a very thin structure of colourless liquid, analogous to the albumen or the white of the hen's egg. The yolk is generally of a yellow colour; but in some species of spider is grey, white, or yellowish brown. The germinal vesicle has disappeared. An opaque white elliptical spot indicates, at this period, the metamorphosed and impregnated centre from which subsequent development radiates. The previous changes which have led to this condition of the excluded ovum have been ascertained to be due to the attraction and assimilation by the primary germ-cell and its progeny of a small proportion of the yolk, which is thus seen to consist of a germ-yolk and a food-yolk. The subsequent processes, up to the complete formation of the young spider, have been described and figured by the accurate and industrious Herold.

The germ-mass consists of derivative germ-cells like minute opaque whitish granules, of smaller diameter than those of the vitellus; in some species Herold observed what he believed to be several germ spots on different parts of the superficies of the yolk, which rapidly coalesced into one body. Development commences by expansion of the circumference of the germ-mass, which, as it expands, covers the yolk with a semi-transparent thin layer, the basis of the future integument. Herold next describes the granules of the germ-mass as being decomposed into almost imperceptible molecules, in which we may recognise the ordinary result of the fissiparous property of its constituent nucleated cells; their powers of assimilation are at the same time manifested by the changes which they effect in the albumen, at the expense of which they seem, in the first instance, to increase their numbers, and diffuse themselves over the surface of the vitellus. This covering of the yolk Herold calls "colliquamentum." He observes, that the original position of the germ-spot is indicated by a clear, transparent point (hyaline?); that this point becomes thickened, pearly, and opaque, so as to conceal the subjacent vitelline cells. A similar change progressively extends over the colliquamentum; and, when one-fourth of the circumference of the yolk is thus covered, the opaque layer has taken on a definite form, resembling the figure 8, the smaller and anterior division being the base of the future head, the posterior and larger one, of the thorax. A fissure is next observed to divide the cephalic from the thoracic portion, the two parts being distinct at this period, and determining the essential nature of the first great segment of the body in the mature spider. The margins of the thorax are next seen to be subdivided on each side by three parallel fissures into four segments; these are the bases of the epimeral pieces. The part of the opaque integument which connects the two series below is the rudimental sternum. A second constriction begins to divide the thorax from the abdomen; the mandibles or antennæ begin to bud forth as two convex processes from the anterior part of the head; the part intervening between these and the epimeral pieces forms the rudiment of the maxillæ. The intermediate labium also begins to be defined from the sternum. The opaque peripheral layer, extending from the thorax to the opposite end of the ovum, lays the foundation of the ventral integument of the abdomen. Upon the opaque integument, which is extending backwards over the dorsal part of the head, the characteristic groupe of simple eyes begins at this time to be distinctly developed, and the rudiments of the maxillary palps and of the four pairs of thoracic legs become recognizable; now, also, the dorsal vessel appears along the upper curvature of the abdomen, and thus all the chief characteristics of the future spider are manifested, whilst the great mass of the vitellus remains still visible through the transparent and incomplete lateral and dorsal parts of the integument.

The constriction between the two divisions of the body increases; the legs and palpi next present slight traces of articulations; as they increase in length they cross the middle line of the sternum and interlock with those of the opposite side. The mouth, the vent, and the wide alimentary canal are formed; the integument is completed, as in other *Articulata*, by a dorsal cicatrix, and in this state the young spider breaks through the attenuated chorion. The jaw-shaped antennæ, the cephalo-thorax, and abdomen, are first extricated, and afterwards, but with more difficulty, the palpi and legs are withdrawn. A similar process has soon to be repeated in the casting off the fœtal integument, which becomes too small for the rapid growth of the young spider. This first moult always takes place in the silken nest of the parent; the young spider then issues forth, and is subject to repeated moults before acquiring the mature size. We perceive, therefore, that throughout the whole process of the development of a spider, there is nothing worthy to be called a metamorphosis. The highest of the Articulata never acquires the condition of the apodal and acephalous worm; the rudiments of the head, with its eye-specks, and of the limbs, are manifested before the vitelline mass is included by the abdominal walls or intestinal membrane: in fact, with the first indications of the characteristic ocelli, trophi, and legs, the cephalothorax and the abdomen are distinctly sketched out, and the special arachnidal form is acquired.

The regeneration of the legs of the spider follows precisely the same law as that which regulates their reproduction in the Crustacea. If the limb be injured at the tarsus, tibia, or femur, it must first be cast off at the coxo-femoral joint, before the process of reproduction can commence, and this must be preceded by a moulting of the integument; the new leg being at first of small size, but with all its joints and appendages, and acquiring the full proportions at the second moult.

The subject of the present Lecture would not be quite completed if I were not to add a few words on the organs for the secretion of the material of the nest of the spider—a silken material which is used, however, for many other important purposes in the economy of these insects, in the fabrication of their abode, of their nuptial chamber, of their trap for catching, and their cords for binding a living and struggling prey. The organs which secrete the material in question, are lodged in the posterior part of the abdomen, and in the *Epeira fasciata*, which is remarkable for the large size of its web, they occupy, when in full activity, about one-fourth of the abdominal cavity. They present the form either of slender and more or less branched tubes, or of dilated sacs, the excretory ducts of which terminate upon projecting jointed organs at the posterior extremity of the abdomen, called spinnarets.

In the *Clubione atrox*, the glands consist of four larger and numerous small tubes: two of the larger branched tubes are twice the size of the other pair. In the genus *Pholcus* the organ is reduced to a more simple condition; it consists of six vesicles of different shapes and sizes; two are large and elongated; they occupy the middle of the under part of the abdomen, and their slender ducts are continued in a tortuous course to the spinnarets; two others are also elongated, but are smaller than the preceding; the remaining two are spherical. The duct of each of these glands terminates upon its appropriate spinnaret, and there are consequently six of these organs.

The *Mygale avicularia* has only four spinnarets, and in the *Mygale cementaria* two of them are imperforate. Six, however, is the ordinary number of spinnarets in the spiders, two of which are longer than the others. The secretion does not issue by a simple outlet, but by a multitude of microscopic pores, which, in the shorter pairs of spinnarets, are prolonged from the terminal surface upon minute processes. If you throw a little dust upon the web of any of the orbitele spiders, of the *Epeira diadema*, for example, you may observe that it adheres to the spiral, but not to the radiated threads. Lyonnet supposed that the adhesive threads issued from tubes, and the others from sessile orifices. The secretion is a glutinous fluid, insoluble in water, and which quickly dries in air; some species, as the *Argyroneta aquatica*, spread their nets habitually under water.

The degree and mode in which spiders exercise this singular secreting faculty varies considerably in the different species. Some, as the *Clubiones*, line with silk a conical or cylindrical retreat, formed, perhaps, of a coiled-up leaf, and having an outlet at both extremities, from one of which may issue threads, to entrap their prey. Others, as the *Segestriæ*, fabricate a silken burrow of five or six inches in length, in the cleft of an old wall. The *Mygale cementaria* lines a subterraneous burrow with the same substance, and manufactures a close-fitting trap-door of cemented earth lined with silk, and so attached to the entry of the burrow as to fall down and cover it by its own weight, and which the inmate can keep close shut by means of strong attached threads.

The arrangement of spiders by M. Walcknaër into families, characterised by their habits, places the principal varieties of their webs in a very concise point of view.

The *Cursores*, *Saltatores*, and *Laterigradæ*, make no webs; the first catch their prey by swift pursuit, the second spring upon their prey by insidious and agile leaps; the third run, crab-like, sideways or backwards, and occasionally throw out adhesive threads to entrap their prey. The *Latebricolæ* hide

in burrows and fissures, which they line with a web. The *Tubicolæ* inclose themselves in a silken tube, strengthened externally by leaves or other foreign substances. The *Niditelæ* weave a nest, whence issue threads to entrap their prey. The *Filitelæ* are remarkable for the long threads of silk which they spread about in the places where they prowl in quest of prey. The *Tapitelæ* spin great webs of a close texture like hammocks, and wait for the insects that may be entangled therein. The *Orbitelæ* spread abroad webs of a regular and open texture, either circular or spiral, and remain in the middle, or on one side, in readiness to spring upon an entangled insect. The *Retitelæ* spin webs of an open mesh-work, and of an irregular form, and remain in the middle or on one side, to seize their prey. Lastly, the *Aquitelæ* spread their silken filaments under water to entrap aquatic insects.

The silken secretion of spiders is not applied only to the formation of a warm and comfortable dwelling for themselves, or of a trap for their prey; it is often employed to master the struggles of a resisting insect, which is bound round by an extemporary filament, spun for the occasion, as by a strong cord. Lastly, a softer and more silken kind of web is prepared for the purpose of receiving the eggs, and to serve as a nest for the young.

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AN EMPEROR IN SCIENCE

The Life of Richard Owen. By his grandson, the Rev. RICHARD OWEN, M.A., etc. Also an Essay on Owen's position in Anatomical Science by the Right Hon. T. H. HUXLEY, F.R.S. London: Murray.

The great palæontologist, anatomist and philosophical naturalist who passed from among us in December 1892 in the fulness of age and glory succeeded to the uncrowned Empire in the realm of Science, vacated by the demise of that scarcely greater philosopher Alexander von Humboldt, in 1858, and at nearly as advanced an age. For the great cosmical traveller was in his ninetieth year, and had the satisfaction of seeing the concluding part of the fourth and last volume of his immortal *Cosmos* in print, before he succumbed to the common lot of man, and Richard Owen had attained his eighty-ninth year when he too passed away in like honour and renown, and, like Humboldt, a good and universally beloved as well as a great man. Like Cuvier, who predeceased him in 1832, Humboldt was born in 1769—a year prolific in famous men, for he, Cuvier, Napoleon, and Wellington date from it, as well as that colossus of finance, George Ouvrard, who not only financed Napoleon's wars, but found the money also for the payment of the indemnity after Waterloo—and by common consent succeeded Cuvier, as Owen succeeded *him* as the admitted leader of science. The life of the late professor by his grandson Mr. Richard Owen is therefore specially welcome, the more so that it contains four excellent photo-lithographic portraits of Owen at different ages, ranging from early manhood to extreme old age. That of Owen in his robes taken in 1846 is especially characteristic. The writer of the present biography, Mr. Richard Owen, has wisely compressed his work within as narrow limits as possible, dealing rather with those details of a personal nature which interest the average reader, who wishes to know the man, and the general outline of his life, and what he has done in science, than with the drier details of his professional career.

The inclusion of a bibliography, chronologically arranged, of all the works and papers written and published by Sir Richard Owen between 1830 and 1887 inclusive, occupying fifty closely-printed pages, with four more taken from a list of Richard Owen's honorary distinctions is a far greater boon to the student and specialist, than any attempt at a summary. There is also a well-arranged index. A classified index of the subjects would increase the boon. Mr. Owen has been greatly aided in his task by the journal kept by his grandmother, Mrs. Richard Owen, from her marriage in 1835 to her death in the spring of 1873 from acute rheumatism. Mrs. Owen was a charming little lady of supreme talent, the daughter of Mr. Clift, Owen's predecessor as Curator of the Hunterian Museum, and, we believe, grand-daughter of John Hunter, with whose name and great reputation her husband's name must always be inseparably connected. An admirable and appreciative wife and mother, her premature death was a great blow to her husband, with whose pursuits she had closely identified herself. Her journal is equally a record of scientific and of home life, and is racy as well as accurate. *Petite* and brisk, she formed an admirable contrast to her tall and dignified but equally genial husband, who never showed to greater advantage than at their hospitable table at East Sheen.

No man enjoyed an honest joke or told a good story better than the great palæontologist, and he simply adored his bright little wife. To his juniors and students Owen was always kind and accessible, and ready to open the rich stores of his knowledge, invariably with tact and temper. Never dogmatically didactic, he was as courteous to a raw student as to a Royal Duke, and no man could give better advice to either. The present writer's knowledge of him and Mrs. Owen dates back to 1847, when Owen's son 'Willy' became a schoolmate at Westminster, though his mother counted Mrs. Owen among the friends of her youth. By the way there is a small error in the journal—'Gambier,' the old negro butler at 'Rigaud's' house at Westminster, did not die from the sewer fever in 1848, but some time previously, and of a strangury. He was a tough old man-of-war's man, who had never before been ill, and the illness of which he died lasted only two days. Mention is made of the hunting up of the coffin of John Hunter in the vaults of St. Martin's Church by Frank Buckland in 1859. He was a great favourite of the Owens as of most people who knew him well, and a frequent visitor at Sheen Lodge. Among the more constant visitors, most of them no more, were Lord Enniskillen, latterly quite blind, but, gigantic and genial as ever, Earl Russell, Edwin Chadwick, John Goold, Edward Jesse, Henry Woodward, Dr. William Russell, Sir Roderick Murchison, Charles Newton, Professor Sedgwick, Charles Dickens, Thackeray, R. D. Blackmore, Tennyson, etc. etc., and no pleasanter gatherings were there than those Saturday and Sunday afternoons on the crisp green turf in the delightful garden of the comfortable and unpretentious Sheen Lodge, the photogravure of which will recall pleasant memories to many. The book, so far as Mr. Owen's own work goes, is a delightful picture of Owen as he really was, and this is due in a great measure to the free use of Mrs. Owen's diary and the Professor's correspondence with his family and most intimate friends. That Professor Owen was so long and so well appreciated by Her Majesty and the entire Royal family cannot but give general satisfaction. It is a curious fact that the title by which he, neither plebeian nor charlatan, was best known, 'Professor,' was first conferred on him by Her Majesty, who wrote him an autograph letter commencing 'Dear Professor Owen,' as we have heard him relate with much gusto.

The book cannot fail to be a mine for later biographers of Richard Owen, it is therefore much to be regretted that Mr. Richard Owen and his family should, in the innocence of their hearts, have asked Mr. Huxley to pen the essay included in the second volume, and still more so that Mr. Huxley should have accepted a task for the acceptance of which he feels it necessary to apologise, and for which notorious past relations with the late lamented head of the philosophical naturalists of Europe obviously unfitted him. Owen might, and Mrs. Owen certainly would, have protested much in the spirit of Lord Brougham's famous and prophetic saying when Lord Campbell's *Lives of the Chancellors* first appeared, 'John Campbell has added a fresh terror to death.' But as Lord St. Leonards treated Lord Campbell's imputations against Brougham and Lyndhurst, so we trust will some scientific Sugden as promptly show up the 'faint praise that damns' thinly veiled in this regrettable essay on 'Owen's position in Anatomical Science.' If a portrait of Mrs. Owen could be added to a later edition it would be welcome to many.

MEMORIAL TO SIR RICHARD OWEN.

On Saturday a meeting was held in the rooms of the Royal Society, Burlington House, to promote the commemoration by a suitable memorial of the services of the late Sir Richard Owen in the advancement of the knowledge of the sciences of anatomy, zoology, and palæontology. The meeting was preceded by the formation of a provisional committee, including the leading naturalists of this and other countries and many others interested in the progress of science generally, the presidency of which had been accepted by the Prince of Wales, with Sir James Paget as vice-chairman, Sir William H. Flower as treasurer, and Mr. W. Percy Sladen as secretary. The Prince of Wales took the chair at the meeting, and was supported by the Duke of Teck, the President, the Treasurer, and the Secretary of the Royal Society, Lord Kelvin, Sir John Evans, and Professor Michael Foster; the President of the British Association, Sir A. Geikie; the President of the Royal College of Physicians, Sir A. Clark; the President of the Royal College of Surgeons, Mr. T. Bryant; the President of the Royal Academy, Sir F. Leighton; the Bishop of Rochester, the Dean of Westminster, Lord Playfair, Professor Huxley, Sir H. Roscoe, M.P., Sir F. Abel, Sir F. Bramwell, Sir G. Stokes, Sir H. Acland, Sir Joseph Lister, Mr. Ericsen, Dr. Priestley, Dr. Günther, Dr. H. Woodward, Dr. Maunde Thompson, Sir W. H. Flower, Sir Erasmus Ommanny, Sir James Paget, Sir Henry Thompson, Sir Spencer Wells, Sir Edwin Saunders, Sir John Fowler, Dr. E. A. Bond, Dr. P. L. Sclater, Mr. Carruthers, and Mr. W. P. Sladen; and there were also present the Rev. Professor J. A. Blake, Professor F. J. Bell, Messrs. F. C. Beddard, F. Gordon Brown, Buckland, H. W. Blake, Dr. G. and Lady White Cooper, Sir T. Crawford, Sir Duncan Campbell, Messrs. A. and E. B. Chancellor, Professor R. K. Douglas, Mr. H. Druce, Mrs. Dawbarn, Lady Flower, Mr. S. S. and Miss Flower, Dr. Edward and Mrs. E. Frankland, Mr. C. E. Fagan, Dr. Fitzpatrick, and Dr. R. H. Fox; Mr. H. Goss, Messrs. F. D. Godman, C. H. Gatty, F. J. Gaat; Drs. H. Hicks, J. Hutchinson, G. Harper, and J. Braxton Hicks; Sir G. M. Humphry, Professor Edward Hull; Messrs. Holman Hunt, A. Highton, E. C. Hulme, and Ernest Hart; Mr. G. A. Ibbetson, Mrs. Lyell; Drs. Michael (President of the Royal Microscopical Society), F. Major, and Meiklejohn; Professor R. Meldola; Messrs. Wilson Noble, M.P., H. A. Miers, and J. H. Mummery; Messrs. R. B. and E. T. Newton; Mrs. Owen, the Rev. Richard Owen, Dr. F. S. Palmer, Dr. F. W. Parry, Mr. M. Pleydell, Mr. Ridewood, Sir T. S. Storey, Lady Smythe; Messrs. H. S. Smith, E. A. Smith, O. Salvin, C. D. Sherborn, Miss Sullivan, Dr. Thorne Thorne, Mr. O. Thomas, Mrs. Visger, the Rev. Professor T. Wiltshire, Messrs. P. Woods, B. B. Woodward, A. S. Woodward, F. G. Waugh, and J. Williams.

The PRINCE of WALES, who was cheered on taking the chair, in opening the proceedings said,—I have the great privilege conferred upon me of being asked to take the chair to-day, upon this very special occasion. We are assembled together for the purpose of paying a mark and tribute of respect and appreciation to the memory of a great man of science who has lately passed away from us. The name of Sir Richard Owen must always go down to posterity as that of a great man one who was eminent in the sciences of anatomy, zoology, and palæontology. Perhaps I may be allowed to say a word of my own personal knowledge of him. It is now 35 years since I had the advantage of knowing him. When I lived as a boy at the White Lodge, Richmond Park, now occupied by my illustrious relative on my right (the Duke of Teck), I had opportunities of visiting him and knowing him. His geniality and his charm of manner to all those who knew him have, I am sure, left a deep and lasting impression. Whether he was explaining to you the mysteries of some old fossil bone that had been given him, or whether he was telling one of his vivid ghost stories, one felt that one was under the charm of his presence. (Cheers.) His method of teaching, as you all know, was earnest and clear in every respect; and it even derived a measure of force from a certain hesitation in his manner. His great repute was gained as a zoologist, and in the study, not only of living animals, but of those long extinct, and following the same large range of work as Cuvier, to whom, in the history of science, he may be regarded as a successor. One of the great works and interests of his life was the formation of the Natural History Museum, which is now safely established in South Kensington under the able guidance of our friend Sir William Flower. It may be within your recollection what great difficulties Sir Richard Owen encountered when he was first appointed Superintendent of the Department of Natural History at the British Museum in 1856. He himself saw in getting that appointment that it was quite impossible that these large collections could be adequately seen unless they were removed to some other sphere. In 1862 a Bill was brought in by Mr. Gladstone, who took the greatest interest in the matter, while it was vigorously opposed, strange to say, by no less great a man than Mr. Disraeli. The Bill was lost, though it was eventually, ten years later, carried, and now we have that fine building that we all know and deeply appreciate. I may also mention that he took the greatest interest with regard to the colonies, and in trying to obtain from them specimens that would be worthily represented in the Natural History Museum. In sanitary matters also he was not behindhand, as was shown by his long intimacy with that distinguished man Sir Edwin Chadwick. There are several resolutions to be proposed, and you will hear far better and more eloquent remarks from the distinguished gentlemen who will move and second them. That is the reason why on this occasion I shall not trouble you with more remarks. Allow me only to repeat the assurance of the deep interest I take in this movement for a suitable memorial to the memory of this great man, and how deeply I appreciate having been asked to take the chair on this interesting and important occasion. (Cheers.)

Lord KELVIN moved:—"That it is desirable that the eminent services of the late Sir Richard Owen in the advancement of the knowledge of the sciences of anatomy, zoology, and palæontology should be commemorated by some suitable memorial." He said that, if there was no other reason but the part that Sir R. Owen took in the establishment of the Natural History Museum and the success that ultimately attended his efforts, he deserved the gratitude of the nation. There was scarcely any branch of the whole of natural history that he had not touched and enriched with the results of his investigations. Three hundred and sixty papers, every one of them valuable, were to be found under his name in the Royal Society catalogue of scientific papers. From these contributions, however, he came back to the Natural History Museum, and he held that every subject of the Queen, in these islands or in the colonies, and every visitor to this country, must feel that he was benefited by the existence of that museum and by the splendid arrangement of its contents.

Professor HUXLEY, in seconding the resolution, said that, if he mistook not, there were very few men living who had had occasion to follow the work of the remarkable man whose career they had met to celebrate with more carefulness and attention than he had done. It was a career remarkable for its length, for the rapid rise to eminence, and the long retention of high position of the person who was the subject of it. It was more than 40 years ago since he, as a young man, had occasion to look abroad upon the scientific world of London, in which he was then a complete novice, and to see whether, perhaps, in some small and insignificant corner of it room might be found for him. At that time there were four persons whose names stood out amongst the first galaxy of scientific men of this country. They were Sir John Herschel, Mr. Faraday, Sir Charles Lyell, and, lastly, though by no means least, the famous Hunterian Professor Owen. If he looked abroad amongst the lights of biological science, with which he was principally concerned, there were Johannes Müller in Berlin, Milne Edwards in Paris, Von Baer in St. Petersburg; but for quantity, general excellence, and variety of work there was no one who could be regarded as the superior of Owen. It was a common impression that Owen was the successor and continuator of Cuvier, and that was largely true. The memoirs on the pearly nautilus, on the marsupials, on the anthropoid apes were fully worthy of the author of the "Memoires sur les Mollusques" or the "Leçons d'Anatomie Comparée," while the "Ossemen fossils" had a full equivalent in the vast series of papers contained in the publication of the Royal, the Geological, and the Palæontographical Societies. It was also to be remembered that in another field Owen was the successor and continuator of the school to which Cuvier was most vehemently opposed—that of St. Hilaire and Oken. The remarkable contributions to morphology embodied in the work on the archetype of the vertebrate skeleton and on the nature of limbs were able developments of speculative views of another order than Cuvier's. Readers of Goethe would remember that he thought the news of the controversy between Cuvier and St. Hilaire far more interesting than that of the Revolution of July, which broke out about the same time. Whether that was a just estimate or not of the relative importance of things might be left an open question; but it was the peculiar irony of history to show us in so many quarrels that right and wrong were on both sides. And in this particular controversy it had turned out that the right lay neither with Cuvier nor with St. Hilaire, but partly with both and partly with a third party, which at that time hardly existed. Whatever might be the ultimate verdict of history in this particular matter, there could be no doubt that it was a distinct aid to progress to have one view of the case stated and illustrated with the unrivalled wealth of knowledge which Owen brought to bear upon it. If history confirmed, as he believed it would, the estimate and broad tendencies of Sir Richard Owen's work, which he had suggested, then it would justify them in endeavouring to preserve the memory of the great work achieved by his stupendous powers of classification, his wonderful sagacity in interpretation, and his untiring strivings towards the ideals which he entertained. (Cheers.)

The resolution was then put and agreed to unanimously, as were also those which followed.

The DUKE of TECK moved:—"That the memorial shall consist primarily of a marble statue to be placed in the hall of the Natural History Museum." His Royal Highness said,—There is no doubt, in my mind at least, that this would be the most appropriate place and the most appropriate form in which to erect the likeness of our admired friend. It is, so to say, his second home, the home of his later labours, and no better place could be found. Besides, I think it is a very nice idea that every one who enters the hall should see first of all the man to whom we owe this inheritance. (Cheers.) Others have said so much about Sir Richard Owen that it is needless for me to go over the ground again. As all of us know so well, what he has been and what he has done will remain in the minds of all who survive him, and, therefore, I will only say that in my opinion the hall, which is a very fine interior, of the Natural History Museum should be the place where the memorial of this great man should be erected. (Cheers.)

SIR W. FLOWER seconded the motion, and said it was proposed, he believed, that the statue should be placed in some permanent position in the central hall. One of the features that distinguished that institution from other museums was that there was a central hall, which might be called an index to the museum, being devoted to the representation of an epitome of all the subjects illustrated in detail in the galleries. He had twice succeeded Owen in the office he held, and had had great opportunities of judging of his character and work. Owen did an enormous amount of work, and his activity and energy were something marvellous. In 1837 Sir R. Owen read a paper before the Royal Society on the brain of the marsupial animals, in which he showed that the brain of these animals differed in some important characteristics from that of the rest of the large group of mammalia to which they belonged. The conclusions of that paper were accepted for nearly 30 years, when, before the same society, a paper was read impugning the accuracy of the observations and conclusions of Sir R. Owen. Last year, at the meeting of the British Association, a paper on the same subject was read by Professor J. Symington, supporting the original conclusions of Sir R. Owen. As the author of the second paper, which had thus been to some extent controverted (laughter), it was only right that he should call attention to the new paper of Dr. Symington when they were assembled to do honour to the memory of the author of the first of this series of three papers, the conclusions of which had been supported after such a great lapse of time. (Cheers.) Of course, they were not certain that the third paper was the last paper on the subject, but he accepted it for the present, and mentioned it in confirmation of the accuracy of the previous observations of Sir R. Owen and as a timely tribute to his memory. (Cheers.)

Mr. P. L. SCLATER (secretary of the Zoological Society) suggested that, in addition, a memorial catalogue of the late professor's writings should be issued, with a portrait and biographical memoir.

SIR JAMES PAGET moved that a committee be formed to carry out the preceding resolutions. It would be impossible, he said, to have any better evidence that the resolutions just passed were right than the number and position of those who had just offered to serve on the committee, for there was never a more representative list of any kind. Headed by the Prince of Wales, the Duke of Teck, the Archbishop of Canterbury, and the Lord Chancellor, it contained nearly 150 of the most prominent workers in all branches of science and many who were the best judges of the influence of science on the general well-being of the nation. He was the oldest person present who had worked with Sir R. Owen and could remember him on entering St. Bartholomew's Hospital as a student in 1834. He could testify to the influence Owen had exercised in promoting the study of science by showing to all around him how keen his delight was in it, and how in itself alone it might be a sufficient reward. He resisted all temptations to leave science, though he might have been a very successful medical practitioner: and he was one of the first by whom the real reform of sanitary matters was begun in this country.

SIR J. EVANS briefly seconded the motion.

SIR A. CLARK moved,—"That the following list of gentlemen constitute the executive committee:—His Royal Highness the Prince of Wales (chairman), his Serene Highness the Duke of Teck, president of the Royal Society, the president of the Royal College of Physicians, the president of the Royal College of Surgeons, the president of the Linnæan Society, the

president of the Zoological Society (treasurer), Sir John Evans, Professor Michael Foster, Dr. A. Gunther, Professor Huxley, Sir F. Leighton, Sir James Paget, Mr. P. L. Sclater, Mr. W. Percy Sladen (secretary), Lord Walsingham, Mr. A. Waterhouse, R.A., and Mr. Henry Woodward." Sir Andrew remarked that this memorial movement reminded them that nations no more than individuals can live by bread alone. Material prosperity did not constitute the true abiding life of a nation; it was necessary that it should live by ideas; and the nation honoured those who, like Owen, communicated new ideas which spurred others to new courses of activity.

Mr. T. BRYANT, in seconding the motion, said the College of Surgeons felt the loss that science had sustained in the death of him who unquestionably was the grand expounder of John Hunter and who more than any one else demonstrated the value of the materials John Hunter left behind him. He did more than any one else to call the attention of the scientific world to the museum in Lincoln's-inn, and by additions to it to make it what it is. More than that, at a time when comparative anatomy and biological studies were little thought of he called attention to the value of them, the necessity for them, and the pleasures they would yield. As a young man he attended Owen's lectures, and felt the full force of his quiet enthusiasm, which was altogether independent of the materials embodied in the lectures.

LORD PLAYFAIR, in supporting the motion, said that he was the last surviving member of the Health of Towns Commission, upon which he was brought into continual intercourse with Sir R. Owen, and therefore he knew how much Sir Richard had at heart the advancement of sanitary science. This interest in it he maintained throughout his whole career. He lived close to Sir Edwin Chadwick, and, although no two men could be more unlike, they were most intimate friends, and were constantly discussing how to advance the health of the nation. When Sir Richard returned from his interesting expedition to Egypt he told the speaker that he had come back in an unforgiving spirit towards Moses because, in appropriating the wisdom of the Egyptians, he had limited himself to ten commandments when he ought to have added as an eleventh, "Thou shalt not pollute rivers." Owen, like Professor Huxley, exercised great influence outside the domain of science. Professor Huxley had benefited the education of the country, and Professor Owen had great influence in improving the sanitary condition of the country.

SIR W. FLOWER read a list of donations, headed with one of £25 by the Prince of Wales.

SIR HENRY ACLAND moved, and PROFESSOR MICHAEL FOSTER seconded, a vote of thanks to his Royal Highness for consenting to become chairman of the committee, and for presiding on the present occasion.

The PRINCE of WALES, in responding, said,—I beg to return my warmest thanks to my kind and valued old friend, Sir Henry Acland, for the way he has proposed, to Mr. Michael Foster for the way in which he seconded, and to you all for the kind manner in which you have received this resolution. It has, indeed, been a labour of love to me to-day to preside on this very interesting occasion, and I think that it has seldom been my good fortune to listen to more interesting or eloquent addresses than those which have fallen from the lips of those eminent gentlemen who have spoken. Nobody will take a deeper interest in the carrying out of this memorial of our lamented friend Sir Richard Owen than myself, and most sincerely do I hope that the great work that is to adorn the Natural History Museum will be worthy of a great sculptor and of the great man that it represents. (Cheers.)

This terminated the proceedings.

INTERIORS AND EXTERIORS. No. 10.

THE MEETING OF THE ZOOLOGICAL SOCIETY, HANOVER SQUARE.

SYNOPSIS OF A COURSE OF LECTURES,

ON THE

OSTEOLOGY AND PALÆONTOLOGY, OR THE FRAME-WORK AND FOSSILS, OF THE CLASS MAMMALIA.

TO BE DELIVERED

In the Theatre of the Museum of Practical Geology, Jermyn Street, on Thursdays and Fridays, at 2 P.M., *commencing on Thursday, 26th February,* 1857,

By PROFESSOR OWEN, F.R.S.,

SUPERINTENDENT OF THE NATURAL HISTORY DEPARTMENTS, BRITISH MUSEUM.

LECTURE I.

Thursday, February 26th.

INTRODUCTORY.

LECTURE II.

Friday, February 27th.

EARLIEST KNOWN FORMS OF THE CLASS MAMMALIA.

INDICATION of the Class in the Upper Trias of Wurtemberg: its Demonstration by three genera of Mammalia, in the Oolitic-slate of Stonesfield, Oxfordshire. The *Thylacotherium:* its characters and species. Former doubts as to its Mammalian nature, and the grounds thereof. *Phascolotherium:* its affinities. Peculiarities of the dentition of those small insectivorous and probably marsupial quadrupeds. The *Stercognathus:* its probable affinities to the omnivorous section of Ungulate or hoofed quadrupeds. More abundant evidence of small Insectivorous and marsupial mammals in the Upper Oolitic beds of Purbeck, Dorsetshire: Characters of the *Spalacotherium*, *Triconodon* and *Hypsiprymnops*. Their association, as in the lower Oolite at Stonesfield, with remains of Insects and Plants. Nature and value of the Negative evidence, in regard to the Mammalian Class, during the Liassic, Oolitic, Wealden and Cretaceous periods.

LECTURE III.

Thursday, March 5th, and

LECTURE IV.

Friday, March 6th.

Examples of the Mammalia first met with in Tertiary Strata—the *Coryphodon* and *Palæocyon*—respectively representing the Ungulate (herbivorous) and Unguiculate (carnivorous) modifications of the Class: their occurrence in the Plastic clay, and equivalent lignites, in England and France. Subdivisions of the *Ungulata*, according to the odd or even number of the toes indicated by Fossils of the London clay, representing the Perissodactyle genus *Lophiodon* and the Artiodactyle genus *Hyracotherium*. Further evidence of Carnivora in the *Pterodon*, and an indication of the Quadrumanous order. More abundant and varied evidence of Mammalian life in the overlying beds of the Paris Gypsum, the Calcaire grossier, and the Fresh-water Eocene deposits of the Isle of Wight and Hordwell. Exemplified by the *Palæotherium* and *Paloplotherium:* by the *Anoplotherium*, *Xiphodon* and *Dichodon:* by the *Anthracotherium*, *Hyopotamus* and *Chœropotamus:* by the *Amphicyon* and *Hyænodon:* by the *Peratherium* or eocene opossum; and by the Cetaceous *Zeuglodon* of the equivalent tertiary formation of North America.

LECTURE V.

Thursday, March 12th, and

LECTURE VI.

Friday, March 13th.

Illustrations of the Miocene Mammalian Fauna. The Dinotherium: its dental characters, large deflected mandibular tusks, probable affinities and principal localities. The *Mastodon longirostris*. The *Tapirus priscus*. The hornless Rhinoceros (*Acerotherium*): the three-hoofed Horse (*Hipparion*): the sabre-toothed tiger (*Machairodus*): the fossil Apes, *Pliopithecus* and *Dryopithecus:* the *Halitherium*, the *Balænodon*, and *Ziphius*, and other fossils of the Red Crag of Suffolk: their abundance and commercial value.

LECTURE VII.

Thursday, March 19th, and

LECTURE VIII.

Friday, March 20th.

Pliocene and Pleistocene species of fossil Mammalia. Their characters illustrated by comparison of the *Elephas meridionalis* with the *Elephas primigenius*, and of the *Rhinoceros leptorhinus* with the *Rhinoceros tichorhinus*. Illustrations of the Mammalian Fauna of the newer Tertiary periods, according to Geographical Distribution. EUROPE AND NORTHERN ASIA. The Mammoth or Hairy Elephant (*Elephas primigenius*): the hairy two-horned Rhinoceros (*Rh. tichorrhinus*): the *Elasmotherium* and fossil Horse, *Hippopotamus major, Sus spelæus, Megaceros, Strongyloceros, Cervus elaphus, C. Tarandus, and C. capreolus, Antilope dichotoma, Ibex, Bison priscus, Bos primigenius* and *Bubalus moschatus. Ursus spelæus*, and *U. arctos; Meles taxus; Hyæna spelæa* and *H. prisca*; *Canis Lupus* and *Vulpes; Gulo spelæus, Lutra, Palæospalax, Trogontherium* and *Castor Europæus;* the *Macacus pliocænus.* Changes in the Geographical condition of Britain indicated by the above fossils.

LECTURE IX.

Thursday, March 26th.

Fossil Tertiary Mammals of SOUTHERN ASIA, exemplified by the following extinct species. *Semnopithecus magnus; Amphiarctos sivalensis; Enhydriodon ferox; Lutra palæindica; Felis cristata; Machairodus sivalensis. Chalicotherium sivalense; Merycopotamus dissimilis; Hexaprotodon silvalensis, Camelus sivalensis;* Fossil Buffaloes, Musk-deer, Cameleopards, and the colossal four-horned Ruminants called *Sivatherium* and *Bramatherium.* The *Hippotherium antelopinum* and *Rhinoceros sivalensis.* The *Dinotherium indicum.* Numerous extinct species of Mastodon and Elephant. Relations of the Tertiary Mammalia of India to the existing Fauna of that continent, to the African fauna, and to the Miocene mammals of Europe.

LECTURE X.

Friday, March 27th.

Pliocene and Pleistocene Fossil Mammals of AMERICA. Preliminary sketch of the existing forms of Mammalia characterizing the Continent of SOUTH AMERICA. Fossil Quadrumana of the genera *Jacchus, Callithrix, Cebus* and *Protopithecus.* Fossil Vampire Bats of the genus *Phyllostoma.* Fossil Carnivora, exemplified by the *Ursus Bonariensis, Canis protalopex, Felis atrox,* and *Machairodus neogæus.* Fossil Rodentia of the genera *Echimys, Ctenomys, Synetheres, Anæma, Cælogenys* and *Hydrochærus.* Fossil marsupial of the genus *Didelphys.* Comparison of the *Mastodon Andium* of S. America with the *Mastodon giganteus* of N. America. The *Tapirus Suinus, Equus curvidens* and *Macrauchenia patachonica.* Fossil peccaries and Ruminants. The *Toxodon platensis,* and *Nesodon imbricatus.*

LECTURE XI.

Thursday, April 2nd.

Fossil American Mammals of the Order BRUTA or EDENTATA. Summary of the existing Forms of this Order peculiar to SOUTH AMERICA. The true Anteaters (*Myrmecophaga*) and the fossil Glossothere. The Armadillos (*Dasypus*): correlated peculiarities of their endo- and exo- skeletons. The first discovered fossils of gigantic species of the mailed Family were referred to the Megatherium: they belong to a distinct genus, *Glyptodon.* Principal species of this genus, the allied *Hoplophorus* and *Chlamydotherium* of the Brazilian bone-caves. Dental and osteological characters of the existing Sloths (*Bradypus*). Gigantic extinct forms of this leaf-eating Family. The *Mylodon, Scelidotherium, Megalonyx* and *Megatherium.*

LECTURE XII.

Friday, April 3rd.

Pliocene and pleistocene Mammals of AUSTRALIA. Summary of existing Marsupial forms of the Class peculiar to this zoological province. Fossil Marsupials in the Limestone and Breccia caverns of Wellington Valley, chiefly remains of young individuals of large extinct species of Kangaroo, Potoroo, and Wombat, probably caught, killed, and dragged into the caves by large carnivorous Dasyures and Thylacines, now also extinct. Fossils of Sedimentary deposits. The gigantic *Diprotodon*, essentially allied to the Kangaroos, but with some of the characters of the Wombat. The *Nototherium inerme.* The great Wombat, (*Phascolomys bovinus.*) Fossil Marsupial carnivora, *Thylacinus spelæus, Dasyurus laniarius,* the great *Thylacoleo* or Marsupial Tiger. The Australian Mastodon.

Concluding Summary of the Genesis, Classification and Geographical Distribution of the Class Mammalia.